ACCLIMATING TO A NEW BAY AREA:

ECOSYSTEM-BASED APPROACHES TO MANAGEMENT FOR THE SAN FRANCISCO BAY

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CONCLUSIONS AND RECOMMENDATIONS

This report is the culmination of two years of work by the 2007-2009 NOAA Coastal Management Fellow, including interviews, literature research, participation in numerous Bay Area projects and programs, conferences, workshops, and the completion of a pilot marine spatial planning project in a portion of San Francisco Bay: San Pablo Bay. The purpose of this report is to provide the San Francisco Bay Conservation and Development Commission (BCDC) with: (1) overall recommendations on how to transition to a more holistic, dynamic, partnership-driven, scientifically-based, and adaptive management approach to managing SF Bay; (2) an identification of the challenges of present and future coastal management in the San Francisco Bay Area; (3) an overview of existing laws and regulations at the national, state and regional levels that provide the legal bases and impetus for EBM and its components; (4) a description of presently used EBM components within the Bay Area along with newer components that would help guide the agency toward broader EBM implementation; and (5) next steps to help ensure both the provision of necessary ecosystem services and the successful adaptation to climate change impacts through ecosystem based approaches to management.

Ecosystem-based management (EBM) is a multi-faceted, integrated approach that strives to maintain healthy, productive, and resilient ecosystems that provide the goods and services required by resident and migrant user populations (necessarily including humans), and is widely supported by members of the academic and scientific communities. However, EBM has been difficult to implement by coastal managers, planners, and other policy decision-makers because of its broad definition and conceptual objectives and its stigma as an approach too-similar-to-be-effective to those of the past. As we struggle with what is often referred to as the approach with the greatest potential of reversing ecological declines and ensuring the suite of ecosystem services which humans need and want, a host of pressures in the San Francisco Bay Area – fishery declines, legacy contaminants, decreases in freshwater inflow from the Delta, invasive species – continue to strain the structure, function, and processes of our natural systems. Add these to the laundry list of emerging issues – increased human uses and activities in the coastal environment, emerging contaminants of concern, and the full range of potential climate change impacts – and it is quite evident that a new and improved strategy is required: one that advances beyond present management approaches often characterized as species- or sector-based, inflexible, and fragmented, to one that is more holistic, place-based, partnership-driven, dynamic, and adaptive.

BCDC has used a collaborative management approach to address its original mandates of reducing fill in the Bay and increasing the public's access to it. Much of its success over the past 45 years can be attributed to the progressive nature of the McAteer-Petris Act and the San Francisco Bay Plan, the conservation focus of the Suisun Marsh Preservation Act and the Suisun Marsh Protection Plan, and the use of place-based Special Area Plans (SAPs). Within these laws and policies are numerous references to, and language containing, inherent EBM principles including: long-term planning; protection of ecosystem structure, process, and function; place-based management; monitoring and review; a strong foundation of science; and collaborative governance. BCDC continues to engage with diverse stakeholders, agencies, governments, and organizations to ensure both the protection of the Bay and the sound development of its shoreline based on these policies. Yet BCDC is largely constrained in its capacity to fully apply an EBM approach by several governance issues: (1) limited authority and jurisdiction (in general, the San Francisco Bay plus a 100-foot shoreline band); (2) a reliance on the continually updated, yet traditional, framework of the San Francisco Bay Plan that is largely sectoral in design and nature; and (3) a largely permit-by-permit regulatory framework that reduces the ability of BCDC to manage more holistically and cumulatively.

Further confounding the ability of the agency to heed the domestic and international political calls to apply EBM has been a relative lack of institutional knowledge about the newer components of EBM, and what it actually means to move toward broader EBM implementation among agencies. On a conceptual level, EBM is simple enough to define: an integrated approach that strives to maintain healthy, productive, and resilient ecosystems that provide the goods and services required by resident and migrant user populations, including humans.[1] Unfortunately, from this broad concept, any number of conceptual objectives – which are designed to be easily understood to a general audience and valid for long periods of time – can be, and have been, interpreted from different perspectives by different agencies. Operational objectives using strategies to implement these conceptual objectives are often classified as the principles or policy goals, and thus the key for effective management using ecosystem-based approaches.

With overarching core elements, underlain by a suite of ecosystem principles, and supported by a variety of tools, EBM can be envisioned as an umbrella approach which contains: (1) *ecosystem principles* such as place-based (or area-based) management, adaptive management, long-term planning, collaborative partnerships, cumulative impact management, and ocean observing, monitoring and review; (2) *core elements* such as marine spatial planning and integrated watershed management; and (3) *tools* such as GIS, habitat conservation tools, sea level rise visualization tools, ecosystem service tradeoff tools, and cumulative impact frameworks. While not all of these components are unique and specific to EBM, brought together they constitute a powerful toolkit for managers and decision-makers: ecosystem-based approaches to management.

It is also true that some of these EBM components have long been employed in coastal and ocean management. Yet solutions to current and future problems begin with implementing the components more comprehensively, as well as implementing newer EBM components, such as marine spatial planning efforts with zoning, integrated watershed management and land-to-sea planning, ocean observing systems and programs, and cumulative impact assessment frameworks. Further, the use and knowledge of the variety of EBM tools that exist can ensure a strong foundation of science is continually being used to better inform decision-makers at BCDC. Governance issues can be aided by: (1) moving toward explicit management goals of assuring ecosystem services, through the establishment of a standardized suite of EBM guidelines in joint venture with other Bay Area agencies and academic institutions, to aid conservation and sound development of sustainable policy, and (2) investigating the structural reorganization of the San Francisco Bay Plan according to ecoregions, which are place-based management areas linking Bay habitats from the subtidal to the intertidal to the upland areas, with associated enforceable and advisory policies.

Using these ecosystem-based approaches to management will also assist with the 21st century's critical challenges of climate change adaptation and mitigation. Public-private partnerships and collaborative interagency efforts can ensure clear and measurable goals across agencies and governments. In addition, ocean observing systems can be used to collect the latest scientific data and help track meteorological and biological trends over time, and adaptive management can aid with uncertainty and variability in future conditions and social values. Finally, EBM tools can help assess, model, visualize, and predict future climactic changes.

[1] McLeod et al. 2005. *Scientific Consensus Statement on Ecosystem-Based Management*. Communication Partnership For Science and the Sea (COMPASS).

Thus, it is recommended that the San Francisco Bay Conservation and Development Commission take the following steps to advance the successful use of ecosystem-based approaches to management in the Bay:

1. **Undertake a study of BCDC and Bay Area governance by: (1) initiating a public-private partnership, similar to the Puget Sound Partnership (or an interagency collaborative effort with Bay Area agencies and academic institutions) to move toward explicit management goals of assuring ecosystem services, through the establishment of a standardized suite of EBM guidelines, and (2) investigating the structural reorganization of the San Francisco Bay Plan according to ecoregions, which are place-based management areas linking Bay habitats from the subtidal to the upland, with associated enforceable and advisory policies.** Ensuring the provision of ecosystem services – provisioning (e.g. seafood), cultural (e.g. windsurfing), regulating (e.g. wetland filtering), and supporting (e.g. nutrient cycling) – is critical to the health and well-being of the San Francisco Bay, its natural resources, surrounding watersheds, the region's economy, and thus the quality of life of the Bay's inhabitants.

   Active partnership in an interagency and interacademic effort to develop and implement a suite of ecosystem-based guidelines would create shared responsibilities and policy direction beyond each institutions mandates and specific responsibilities. Guidelines could be general such as, "The provision of ecosystem services shall be assured for present and future generations and is the highest management priority for all agencies," or more specific such as, "All agencies shall move toward reducing the amount of discharge to the Bay's waters, with the goal of the entire Bay becoming a no discharge zone by 2020." Knowledgeable scientists and collaboration with an organization like the Communication Partnership for Science and the Sea (COMPASS) should be included in crafting these guidelines.

   A restructuring of the Bay Plan to include findings and policies based on designated ecoregions (which incorporate subtidal, intertidal, and upland areas as single, interconnected management units) would create less of a reliance on sector-by-sector management and create better linkages between habitats in the Bay Area. These ecoregions, or priority ecosystem zones, are based upon bathymetry, habitat type, salinity, species composition, and watershed boundaries, instead of on political boundaries or individual human uses and activities, such as transportation. Further changes to the Bay Plan may also include greater use of Special Area Plans, which have the ability to manage a particular place and the entirety of its human uses and activities to ensure the assessment and management of their cumulative impacts.

2. **Undertake further study of marine spatial planning (MSP) in preparation for potential state and federal comprehensive zoning efforts, by initiating a research, data acquisition, and mapping effort of San Francisco Bay's current and future human uses, *de facto* zones, and submerged habitats.** Marine spatial planning is dependent upon a baseline set of knowledge of current human uses, *de facto* spatial zones, habitats, and ownership, as well as all potential future uses, such as increased ferry usage, LNG facilities, desalination plants, new restoration projects, and shoreline structures. The San Pablo Bay Marine Spatial Planning Pilot Project (SPBMSP) succeeded in showcasing the datasets, along with the current and potential future spatial and human use conflicts and the benefits that various zoning scenarios may achieve to enhance cumulative impact management and ecosystem services protection.

   Several recent national reports, plans, initiatives, and legislation support, recommend and promote ecosystem-based approaches to coastal and ocean management. Various efforts to implement these approaches are underway or have been completed, including the West Coast EBM Network and the California Current EBM Initiative. In addition, the California Marine Life Protection Act (MLPA) is scheduled to be implemented in San Francisco Bay with the objective of establishing marine protected areas, or zones. Expanding the SPBMSP by researching, acquiring, and mapping data bay-wide will

provide the necessary information for any future Bay spatial planning effort. Taking the lead on the collection and management of the data will secure BCDC's position as a lead agency in any Bay zoning effort, thus ensuring that the aims and requirements of any such effort are coordinated within BCDC's mission and objectives.

3. **Increase active partnership with integrated watershed management programs to engage more comprehensively in land-to-sea planning efforts, and ensure the collection of the scientific data required for these efforts.** Runoff from residential and industrial landscapes, urban waterfronts, agricultural lands, and other land-uses affect the quality and health of the Bay and thus the quality and health of the Bay's inhabitants. Increased nutrients have the potential to increase the number of harmful algal blooms and bacteria and contaminants can result in closures of the Bay's rare beaches, poison fish consumed by humans, and degrade the natural beauty and human enjoyment of the Bay. While too much sediment draining from upland sources increases turbidity downstream to the detriment of eelgrass and other submerged aquatic vegetation, sediment is critical for successful wetland transgression with a rising sea.

   Efforts to combine watershed management programs with marine spatial planning efforts should be undertaken to connect the Bay's habitats from subtidal to upland and more comprehensively manage the Bay's ecosystem. Collaborative efforts linking these environments can increase the synthesis between land-uses and water-uses and can reduce fragmentation of management across environments.

   Successful efforts to understand those linkages and processes between the subtidal, intertidal and upland environments require current and accurate data such as submerged lands habitat-type information, topographic and bathymetric data, and sediment flow/change models. Engaging in active partnership with watershed management efforts around the Bay Area, especially within the Sacramento-San Joaquin River Delta, will ensure that BCDC is kept informed of data gaps and needs, contaminant issues, land-use decisions, species migration patterns, restoration efforts and other issues, which are all critical to ensuring the conservation and sound development of the Bay and its shoreline.

4. **Undertake a comprehensive, quantitative evaluation of the cumulative impacts of the Bay Area's human uses and activities on the Bay's habitats through an analytical framework such as that developed by the National Center for Ecological Analysis and Synthesis (NCEAS), University of California Santa Barbara.** A key gap in today's coastal and marine management approach is the lack of an adequate assessment and management strategy to deal with cumulative impacts of human stressors. A framework has been created for quantifying and mapping the impacts of multiple human activities on ecosystems and habitats around the world to address the needs of decision-makers.

   A scaled down framework such as this would allow BCDC to better understand the holistic landscape of human uses and activities by quantitatively gauging the levels of impacts of them on the Bay's critical habitats. The benefits and policy implications are numerous. For example, cumulative impact maps can provide concrete guidance on where conservation action may be most critical, where mitigation of key human uses and activities is most needed, and where various activities are compatible. These benefits also extend into the future where potential human uses and activities, including those related to climate change, such as sea surface temperature and ocean pH levels, can be proactively assessed and mapped to measure their individual and cumulative impacts in conjunction with other uses and activities occurring in the Bay Area. Accurate data on the Bay Area's habitat types are required for this analysis.

5. **Increase active partnerships with regional ocean observing programs to ensure that a strong foundation of science is informing planning and policy decisions about regional and local sea level rise, ocean acidification, and other climate change impacts to the Bay Area.** Biophysical changes due to climate change occur on global, regional, and local scales. Ocean observing systems are necessary to track and monitor current oceanographic states and trends and thus helps predict future changes to the Bay and its shoreline. In addition to collecting meteorological data (ocean temperatures, currents, salinity, etc.), ocean observing systems have the potential to collect increasing amounts of biological data, which could be used to map larval dispersal patterns, native and invasive species migrations due to climate change, and the spread of harmful algal blooms.

   The Central and Northern California Ocean Observing System (CeNCOOS) is in the initial stages of a San Francisco Bay initiative to increase the amount, and usefulness of both types of data in the Bay to agencies, governments, and organizations for a variety of applicable science and policy purposes. In general, this type of data can support and justify BCDC's science-based policy decisions and thus ensure that the agency is at the forefront of climate change science and policy and can assist in the informed outreach to local Bay Area governments. More specifically, ocean observing data on larval dispersal patterns and/or fish migrations could be used to inform dredging management decisions and plan for the appropriate siting of new dredged sediment-holding areas for restoration projects.

6. **Create and provide training opportunities for staff on the latest and most relevant EBM tools and technologies (e.g. GIS, habitat conservation tools, sea level rise visualization tools, ecosystem service tradeoff analysis tools, marine protected area optimization tools, etc.) and pursue the hiring of an individual with the technical skills to use and teach these new tools.** The need for all of these tools is necessitated by interconnections within the ecosystem, but also by the need to balance competing uses of natural systems and maximize the health of and benefits from these systems. Various tools can model different types of connectivity to help managers understand how locations are connected and how to better address and accommodate this interconnectedness in management decisions. These connections include linkages between sectors (e.g. sediment flows and habitat type) and among environments (land, sea, and air).

   In general, the use of the latest EBM tools would allow BCDC to incorporate connectivity information into the decision-making process and aid in evaluating management alternatives, as a means to satisfy the need for a strong foundation of science to support the agency's policies and findings. Staff will be able to use these new tools and technologies for a wide variety of purposes, such as siting future restoration projects, creating setbacks for new coastal developments to protect from sea level rise, and planning for marine protected areas within the Bay. However, to allow for this, the tools must be accessible and easy to use. The hiring of a full or part-time staff member (or consultant) with the technical skills to use, assist, and teach these new EBM tools should be a priority.

INTRODUCTION

"San Francisco Bay is an irreplaceable gift of nature that man can either abuse and ultimately destroy – or improve and protect for future generations" – San Francisco Bay Plan

San Francisco Bay is the largest and one of the most heavily managed estuaries along the Pacific Ocean's eastern edge. Numerous *sectors,* or human uses and activities – dredging, fishing, residential land development, recreational boating, sand mining, wastewater treatment, shipping, etc. – in and around San Francisco Bay affect the San Francisco Bay ecosystem and the socioeconomic region as a whole. These individual sectors are managed by a variety of public and private entities – governments at all levels, agencies, and organizations – in attempts to ensure that the environment and the economy are in relative balance. Stressors to ecological systems in the Bay Area, among them fisheries declines, water and sediment contamination, coastal development pressures, invasive species, reductions in freshwater inflow, and marine debris combine in cumulative ways to negatively affect the health and functionality of the ecosystem and to limit the socioeconomic potential of the region. Projected climate change impacts, such as sea level rise and changes to the Bay water's pH, salinity, temperature, and species composition, will add to the pressures currently straining the system.

In 2003 and 2004, two high-level national ocean reports were published calling for the implementation and use of ecosystem-based management (EBM) as a cornerstone for reversing current ecological declines in the marine environment. Generally referred to as an integrated approach to management that considers an entire ecosystem, including humans, EBM has been difficult to comprehend and implement in the manner in which it was broadly defined. Still, the concept is widely supported by the academic and scientific community, and since then, other reports and various state and federal laws and policies have followed suit by espousing a wide range of recommendations and mandates for improved ocean health based on ecosystem-based approach to management. Most of these same academics and scientists believe this approach to be our best chance of restoring healthy oceans and ensuring the provision of ecosystem services to both human and natural communities. As climate change impacts and adaptation, along with new human uses and activities, rise to the forefront of policy and management, BCDC will need to upgrade its collaborative management approach to include a suite of new EBM components: elements, principles, and tools. These are ecosystem-based approaches to management.

CHAPTER 1

THE SAN FRANCISCO BAY AREA AND COASTAL MANAGEMENT

The San Francisco Bay Area is a priceless natural resource that provides countless benefits to residents and visitors. The Bay itself supports over 130 species of fish, which help sustain the Bay's foodweb and provide opportunities for recreational, commercial, and subsistence fishing. Pickleweed, cordgrass, Dungeness crabs, harbor seals, sea lions, mice, toads, snakes, gulls, geese, cormorants, and thousands of other species of wildlife migrate through and reside in and around the Bay's cool waters, marshes, and mudflats. Hundreds of thousands of birds migrating between the Arctic and South America – roughly 50 percent of the birds using the Pacific flyway – rest and feed on and around the Bay. For humans, the Bay's waters provide essential *ecosystem services*, such as fish, sand, and other provisioning staples; recreational and cultural opportunities like windsurfing and sailing; nutrient cycling, wetland filtering of pollutants and other biophysical support measures; and regulating services such as the control of the Bay's temperate climate. The Bay's overall beauty is a central factor in the region's tourist industry, which attracts millions of visitors and millions of dollars from around the world every year.

The Bay's roughly thousand miles of shoreline is the setting for diverse communities and varied coastal habitat. Public access to the Bay's edge allows for countless opportunities for recreational enjoyment, both along and within the Bay. The shoreline is home to vital infrastructure such as schools, hospitals, roads, railways, airports, and wastewater treatment plants. Oil refineries, ports, marinas, salt-producing ponds, duck clubs, and golf courses combine to power the economic engine and cultural standing of the San Francisco Bay Area, and California as a whole. Vibrant urban waterfronts and industrial areas, charming coastal enclaves, calming wildlife refuges, parks and beaches, and diverse residential neighborhoods form a mosaic of interconnected places and provide a quality of life unmatched in many parts of the world.

Surrounding the Bay's immediate shoreline is the nine-county Bay Area, which includes the mouth of the Sacramento and San Joaquin River Delta. This precious and contentious resource funnels freshwater from the Sierra Nevada Mountains into San Francisco Bay and functions as a salinity regulator, drinking water supplier, habitat provider, and more. Greater than 7 million acres of farmland, on which 45% of the Nation's fruits and vegetables are grown, are irrigated by water diverted from the Delta. Approximately two-thirds of all potable water for homes and businesses in California flows down through this system.[2]

Extending beyond the immediate political jurisdictions of the nine-county Bay Area, the entire San Francisco Bay watershed encompasses over 68,350 square miles from Oregon to Southern California and into Nevada (Figure 1). This ecosystem is interconnected with the Pacific Ocean through tidal exchanges, sediment flows, and species movements.

[2] See more information on the SF Bay-Delta Estuary at http://sfep.abag.ca.gov/pdf/fact_sheets/SF_Bay_Delta_Estuary.pdf.

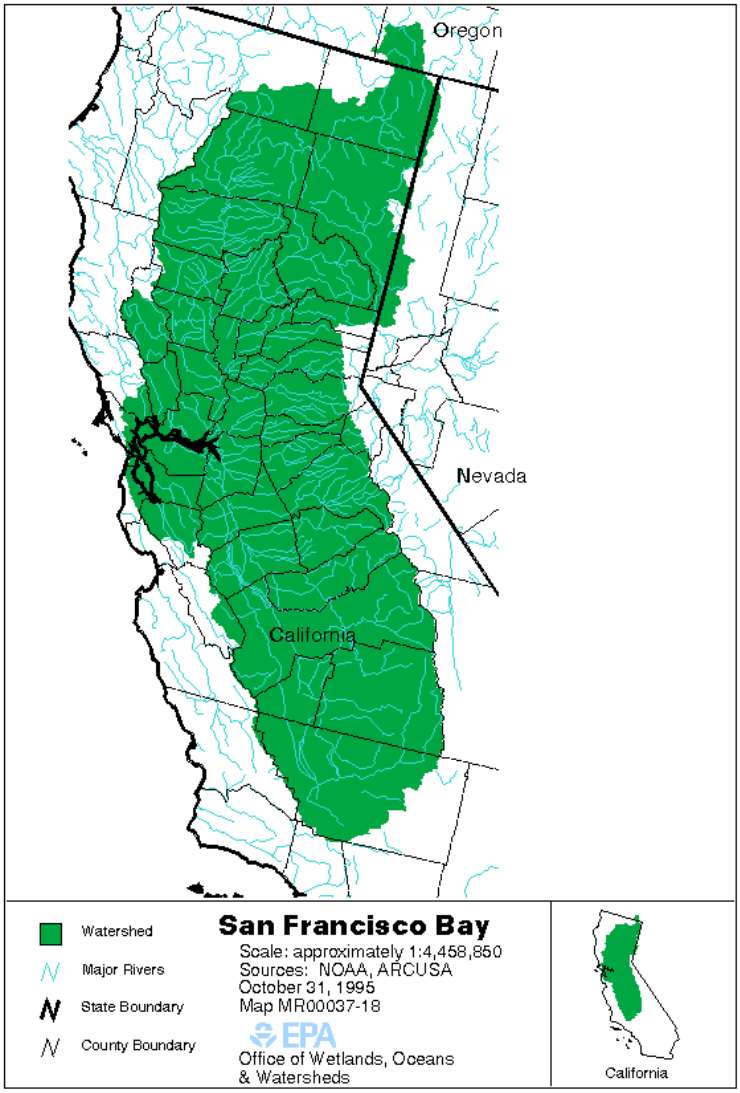

Figure 1. The San Francisco Bay Watershed. 1995. Sources: EPA, NOAA, ARCUSA.

The San Francisco Bay shares similarities with other coastal ecosystems (defined here as geographically specified systems of organisms, including humans, the environment and the processes that control the system's dynamics) in various stages of degradation throughout the world. For decades before and after the environmental movement of the late '60s and early '70s, most scientists, managers, and policy-makers believed the sea to be a bountiful, inexhaustible natural resource. Indeed, the 1969 Stratton Commission, the predecessor to the Magnusson-Stevens Fisheries Conservation and Management Act (FCMA), largely recommended policies to coordinate the proactive development of ocean resources. Today it is widely believed that the results of this mentality towards the oceans, expressed primarily in the form of open or loosely regulated access to ocean resources, has led to the current plight confronting the marine environment.[3]

[3] Elliott A. Norse. 2005. *Ending the Range Wars on the Last Frontier: Zoning the Sea*. Marine Conservation Biology, pp. 422-444.

This is especially true of the overexploitation of fish stocks including the ocean's top predatory species, such as tuna, swordfish, and shark. Current impacts now extend far beyond a single species or a single sector to include whole regions of the seas due to the ever-expanding number of ocean users, activities, and coastal development impacts. Disruptions and fragmentation of important habitats such as seagrass, mangrove and kelp forests, coral reefs, and estuarine ecosystems are seen as larger negatives than simply the decline of a single species. Where once isolated species were fished or poisoned to the brink of extinction, now entire food webs are harmed by human practices in the water.

Under-regulated land development near the ocean's edge and alongside its rivers and other tributaries has added to these ecological problems. According to the U.S. Commission on Ocean Policy, poorly planned land growth reduces and fragments fish and wildlife habitat and alters sedimentation rates and flows. It is also well understood that development in coastal areas contributes to water pollution, with impacts on fishing, swimming, and many other recreational and economic activities. Some evidence indicates that ecosystem health may be seriously impaired when impervious areas (parking lots, houses, roads, etc.) in a particular watershed reaches or exceeds 10 percent, particularly in the absence of mitigating factors, such as a high percentage of wetlands or forest cover in a watershed, or riparian buffers along streams.[4]

While the Bay, including its shoreline and upland watersheds, has been thoughtfully managed over the past several decades by federal, state, and local agencies, and numerous non-profit organizations, complex pressures are straining the Bay's health and vitality in increasingly interconnected ways. In the San Francisco Bay Area, several regional issues stand out as areas of concern. In addition, new impacts as a result of climate change are likely to exacerbate these issues.

Bay Area Resource Concerns

One of the most widely recognized resource concern is the decline of the Bay's fisheries. Over the past decade researchers have witnessed a precipitous drop in returning salmonid numbers from the ocean, forcing the California Department of Fish and Game (DFG) to close the entire California salmon fishery in 2008 and 2009. Recent trends are not encouraging. Chinook and coho salmon, and steelhead trout have biological connections to the Bay Area's creeks, streams, and major rivers, and all are in the midst of serious declines. Because salmonids require clean, cold streams and cold, productive oceans, they are excellent indicators of both general ecological health and climate. Degradation of spawning streams due to dams, pollution, and warmer water, as well as increasing variability in ocean productivity, are the key reasons for the declines.[5] In addition, in June 2009, the Bay's herring fishery was ordered to close by the DFG, again citing low population numbers.

By 1998, shipping and ballast water exchanges and other releases of exotic organisms have resulted in the introduction of over 200 non-native plant and animal species into San Francisco Bay.[6] A 1995 study on biological invasions by the San Francisco Estuary Institute (SFEI) found on average that one invasive species arrives in the Bay every 14 weeks. A number of non-native species, such as Atlantic cordgrass, invasive Spartina, and the Asian mitten crab, limit the ability of native flora and fauna to flourish. Exotic organisms continue to dominate several key habitats, in number of species, number of organisms and biomass.[7] In general, invasive species

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[4] U.S. Commission on Ocean Policy, *An Ocean Blueprint for the 21st Century*, Final Report. 2004.
[5] Martin, Glen. January-March 2009. *Taking the Heat: Bay Area Ecosystems in the Age of Climate Change*. Bay Nature, Bay Nature Institute: Berkeley, CA.
[6] The Bay-Delta harbors approximately 750 plant and animal species. Estimates believe that up to 99 percent of living matter is non-native. See http://www.exoticsguide.org/ or SFEI at http://www.sfei.org/bioinvasions
[7] Some experts estimate that up to 99 percent of the Bay's biomass is non-native.

reduce biodiversity in an area, as most have an advantage over native species due to a lack of natural predators. Despite tremendously expensive efforts to reduce further introductions of invasive species, to eradicate certain species and to control the spread of species once established, invasive species continue to arrive in numbers that surpass the capability and resources to combat them.

Water pollution also remains a problem, though considerable progress has been made in improving the quality of the Bay's water through better treatment of sewage and reductions in point-source pollution, primarily due to the efforts of both the State and Regional Water Quality Control Boards. However, legacy contaminants originating from California's gold-rush era continue to impact fish and wildlife. Contaminants that threaten the Bay's fish, wildlife, and humans still arrive from agricultural lands into the rivers that empty into the Bay and from urban areas surrounding the Bay. Methylmercury concentrations, for example, have been relatively constant since the early 1970s.[8] Mercury is the primary cause of the fish consumption advisory for the Bay, and concentrations of methylmercury in sport fish show no sign of declining.[9] Polychlorinated biphenyls (PCBs) and dioxins continue to be found, and emerging pollutants such as pyrethroids, Compounds of Potential Concern (CPCs) – which include a class of flame retardants called polybrominated diphenyl ethers (PBDEs) – endocrine disruptors, and residues from medicines and personal care products, are now being tested for, and found, in all parts of the Bay.

Sewage spills from antiquated wastewater treatment plants and stormwater overflows during peak rains contribute to unhealthy levels of pathogens for fish, wildlife, and humans at various periods throughout the year. Point and non-point source runoff, marine debris, and infrequent but significant oil spills continue to degrade the vitality of the Bay's ecosystem. Richardson Bay remains the only area in the Bay to be an Environmental Protection Agency designated No Discharge Zone.[10]

Besides straining the functionality of the ecosystem, these pressures affect the Bay Area on a number of socioeconomic levels as well. In general, this largely occurs by diminishing the economic productivity of the area and the socioeconomic wellbeing of the millions of Americans who use, visit, and depend on the goods and services that it provides.[11] For example, the Cosco Busan oil spill on November 7th, 2007, in addition to directly killing hundreds of birds and other wildlife and impacting a variety of Bay habitats, delayed the start of the Dungeness crab fishery season for several months causing significant economic hardship to the industry. The closure of the Californian salmon fishery for a second straight year has cost California an estimated 460 million dollars,[12] with no sign of reprieve. It is unknown what the economic impact of the more recent closure of the herring fishery will be on that industry, nor is it known what the impacts of all closures will have on the Bay Area's recreational industry. A study of the economic impacts of human uses on the Bay's subtidal habitats released last year

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[8] See *The Pulse of the Estuary* (2008), A Report of the Regional Monitoring Program for Water Quality in the San Francisco Estuary

[9] *Id.*

[10] "No Discharge Zones" (NDZs) are designated bodies of water where the discharge of treated and untreated sewage from vessels is prohibited. Federal Law prohibits the discharge of untreated sewage from vessels within all navigable waters of the U.S., which include territorial seas within three nautical miles of shore.

[11] Linwood Pendleton. 2007. Executive summary to *the Economic and Market Value of Coasts and Estuaries.* Restore America's Estuaries.

[12] Extrapolation based upon data from Neil Manji, branch chief of the Department of Fish and Game's inland fisheries division, and based upon 2008 numbers of economic loss.

by the non-profit Battelle Memorial Institute indicates that millions of dollars are brought in to the local economy every year by such human uses and activities as recreational fishing, hunting, birdwatching, and mineral extraction (such as sand mining, salt harvesting, and oyster shell mining),[13] and which could be lost with further ecological damage.

In addition to these stressors, projected sea level rise associated with climate change may further challenge the socioeconomic integrity of the Bay Area. The Intergovernmental Panel on Climate Change along with other climate scientists predict global temperatures will inevitably increase between 1° and 3° C (1.8° to 5.4° F) over the next century, and thus adapting to climate change and its impacts is both unavoidable and essential. In San Francisco Bay, the California Climate Action Team along with other climate scientists are predicting a sea level rise of 16 inches (40 cm) by mid-century and of 55 inches by the end of the century.[14] Without intervention, rising waters are likely to inundate essential high value infrastructure such as airports, wastewater treatment plants, and ports. Silicon Valley, Mission Bay, the productive agricultural fields of the Delta region, and the highly invested-in salt pond and wetland restoration projects around the Bay all have the potential to be negatively impacted. This inundation will unarguably cause increased hardship for property owners, industries, cities and counties, and for the management agencies that oversee these lands.

Sea level rise, however, is only the most visible and publicized aspect of climate change that the Bay Area will confront. Changes to the Bay water's pH, salinity, and temperature, along with expected changes in species composition/migrations and regional precipitation and runoff patterns, all have the potential to alter the Bay's ecosystem and disrupt its ecosystem services to an equal or greater extent than sea level rise. For example, warmer air temperatures may prevent cool waters in the Pacific Ocean, rich in oxygen and nutrients, from circulating to the surface and to various parts of the California coast and the Bay.[15] When combined with numerous new and existing pollutants and altered tidal circulation, these effects may produce algal blooms resulting in reduced water oxygen levels.[16] Adapting to sea level rise and other climate change impacts could lead to further impacts depending on what strategies are used and how frequently they are employed.

Ocean acidification is another example of a climate change impact with significant potential implications on the ecological and socioeconomic state of the Bay Area. Increased carbon dioxide levels in the water can cause acidification of the Bay's waters and will reduce the amount of calcium carbonate available for shell production for marine "calcifiers" – oysters, mussels, clams, as well as pteropods – a significant forage species for salmon and other fish.[17] Studies in other areas of the world are already linking the increases in ocean acidification to oyster population declines.[18]

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[13] *Conceptual Benefits of Protection, San Francisco Bay Subtidal Habitat Goals Project.* 2008. Battelle Memorial Institute, submitted to NOAA.

[14] Numbers based upon research by Noah Knowles, USGS and Dan Cayan, California Climate Change Center. See Knowles, Noah. 2008. *Potential inundation due to Rising Sea Levels in the San Francisco Bay Region*, California Climate Change Center, CEC-500-2009-023-F and Cayan, Dan et al. 2008. *Climate Change Projections of Sea Level Extremes Along the California Coast.* Climate Change. 87 (Supplement 1): S37-S73. DOI: 10.1007/s10584-007-9376-7.

[15] Harley, C.D.G. et al. 2006. *The impacts of climate change in coastal marine systems*. Ecology Letters. Vol. 9, pp. 228-241.

[16] San Francisco Bay Conservation and Development Commission. 2009. *Living with a Rising Bay: Vulnerability and Adaptation in San Francisco Bay and on the Shoreline.*

[17] See *Ocean Acidification linked to Oyster Declines*. May 27, 2009. *PLoS ONE* http://www.eurekalert.org/pub_releases/2009-05/plos-sfa052609.php and Taking the Heat, *supra* at 4.

[18] *Id.*

Collaborative Management and Bay Area Governance

Political decisions have divided up jurisdictional boundaries across the San Francisco Bay ecosystem fragmenting its management into a patchwork of local, regional, state, and federal government entities with differing mandates and legal authorities. Fifty-two local governments have broad decision-making authority over land-use planning yet lack the policy incentives, resources, and regional guidance to manage their individual sectors together. Within the nine-county Bay Area encompassing approximately 7,000 square miles, there are 101 cities and towns, over 1,000 special purpose districts and 26 transit agencies. The California State Lands Commission oversees the public trust for the state-owned submerged lands of the Bay, yet almost 40 percent of the Bay's submerged lands are owned by a mosaic of private, non-profit, special districts, and other public entities. Additionally, a host of federal entities such as the U.S. Environmental Protection Agency, U.S. Coast Guard, U.S. Fish and Wildlife Service, and the U.S. Army Corps of Engineers have vested legal interests and responsibilities in the management and maintenance of the Bay, its human uses and activities, and its surrounding watersheds.

Through the efforts of the Save San Francisco Bay Association that passed a legislative moratorium on filling the Bay (the McAteer-Petris Act), BCDC was formally established in 1969 as the state agency responsible for planning protection of the Bay, regulating shoreline development, and ensuring public access to the Bay. BCDC's jurisdiction under the McAteer-Petris Act includes the Bay's waters, tidal flats, marshes, managed wetlands, certain waterways, salt ponds, and a thin shoreline band generally extending 100 feet from the mean high tide (MHT) line. Essentially created to block the dumping and filling in of San Francisco Bay's shallow environments for development, and to increase the public's access to the Bay's shoreline, BCDC has since permitted over 300 miles of public access and aided in the expansion of the Bay by approximately 2300 acres with the addition of several large-scale wetland restoration initiatives. The McAteer-Petris Act and the San Francisco Bay Plan are the principle documents that authorize BCDC's regulatory, planning, and enforcement decisions. In 1977, the Suisun Marsh Preservation Act expanded the Commission's authority to provide protection of the Suisun Marsh. Several Special Area Plans (SAPs), such as those for Richardson Bay and the San Francisco Waterfront, have been produced providing greater detail for a particular area's management needs than what is in the McAteer-Petris Act or Bay Plan. Numerous collaborations exist focusing on addressing many of the region's most important issues concerning air and water quality, fisheries and invasive species, sediment and watershed management, and wetland and salt pond restoration.

Sustaining and improving the Bay's natural resources is vital to ensuring the host of ecosystem services that humans need and want. Thus, accomplishing this complex task necessarily means managing beyond an agency's bounded political environments and working more closely and collaboratively with other entities. Indeed, it is often a limited and fragmented political environment, combined with an ever-increasing realization of the ecological concerns and complexities of ecosystems and socioeconomic realities that has required the use of collaborative management by many Bay Area agencies, including BCDC.

Despite this collaborative management approach, the decline of coastal and ocean health continues in the Bay Area, as it does in many parts of the world. This decline stems from a fundamental mismatch between the way ecosystems function and the way the activities that impact them are managed. Essentially it is the idea that coastal and ocean ecosystems do not fit neatly within the jurisdictional boundaries that determine various governmental regulatory and management authorities. This necessarily creates a fundamental inability to effectively address the complex challenges that coastal ecosystems face.[19]

[19] The Joint Ocean Commission Initiative (JOCI) is comprised of various representatives from both the Pew Oceans Commission and the U.S. Commission on Ocean Policy. See more at

CHAPTER 2

MARINE ECOSYSTEM-BASED MANAGEMENT[20]

Ecosystem-based management (EBM) rose to a mainstream concept in the 1990s as an approach designed to more efficiently incorporate the idea of ecological and socioeconomic connectivity and holism. Since then, scientists, academics, and other proponents have had difficulty conveying the intricacies of EBM to coastal managers, policy makers, and the general public.

In 2003 and 2004 respectively, the Pew Oceans Commission and the U.S. Commission on Ocean Policy were published calling for the implementation and use of ecosystem-based management (EBM) as a cornerstone for reversing current ecological declines in the marine environment. Other reports and various state and federal Acts have espoused a wide range of recommendations and mandates for improved ocean health based on using ecosystem-based approaches to management. Defined generally as an integrated approach to management that considers the entire ecosystem, including humans, EBM has been difficult to comprehend and implement. Still, the concept continues to be widely supported by the academic and scientific community.

In general, EBM represents a move away from species-based and sector-based approaches to management. With single-species management, energy is focused on the dynamics of particular species without comprehensive regard to the interactions between those species or other components of the ecosystem. In the marine environment, some of the direst examples of the problems with species-based management are seen in traditional fisheries management. This approach is narrowly focused with the goal of sustaining harvested fish stocks in order to maximize their yield for human use. The EBM approach, conversely, would differ in two main ways: (1) by aiming to control fishing to avoid ecological harm by conserving not just the fish being harvested (through quotas, fisher days at sea, etc.) but also by conserving their predators, prey, and underlying habitat that sustains all marine life,[21] and (2) by aiming to impart a socioeconomic aspect by addressing livelihood concerns of fishers and attempting to manage human behavior across sectors (e.g. between fishing, dredging, water quality, and eelgrass habitat restoration).

EBM also represents a transition away from sector-based approaches to management. Various sectors mentioned above have traditionally been managed in relative isolation from the others. EBM recognizes that these sectors are all interconnected, and in the *long-term*, dependent on one another. Solving problems in one sector requires collaboration with the others. For example, commercial and recreational fishing interests concerned with salmon or shellfish have gradually started thinking about how the survival of these species are related to other issues such as dam removal, eelgrass restoration, and water quality.[22]

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www.jointoceancommission.com for the report, "One Coast, One Future: Securing the Health of West Coast Ecosystems and Economies."

[20] For the purposes of this report, the term "EBM" will be used in shorthand for "marine ecosystem-based management." Additionally, for the most part, the term "ecosystem-based approaches to management" will be used instead of "EBM," since the former emphasizes the importance of the individual components of EBM while the latter portrays the notion that EBM is a single one-stop panacea. Finally, EBM is often referred to as Area-Based Management (ABM).

[21] Brad Warren. 2007. *Sea Change: Ecological Progress in U.S. Fishery Management*. A report jointly commissioned by the institute of Social and Economic Research (ISER) and the Marine Conservation Alliance.

[22] Susan Senecah et al. 2006. *Ecosystem-based Management in New York State: Taking the Next Steps.* Summary Report to the New York Ocean and Great Lakes Ecosystem Conservation Council.

In 2005, the Communication Partnership for Science and the Sea (COMPASS) produced a document that clarified and explained EBM.[23] Over 200 leading academic scientists and policy experts came together, recognized and agreed that the current state of the oceans requires immediate action and attention. The definition they developed is still the standard used today:

> EBM is a multi-faceted, integrated approach that strives to maintain healthy productive and resilient ecosystems that provide the goods and services required by resident and migrant user populations, including human.[24]

A standard definition is a valuable contribution to the advancement of EBM. More important is recognition that the definition is less important than the components contained underneath EBM.[25] EBM is best conceptualized as an umbrella approach encompassing a suite of *ecosystem-based principles*, which are incorporated into larger place-based practices, or *core elements*. These core elements are supported by a growing number of *EBM tools*. All of the principles, elements, and tools have been proven effective in various projects and programs, both in the United States and internationally. Together these EBM components constitute a powerful toolkit to build on existing management approaches.

Ecosystem-Based Principles

Underlying any EBM efforts are the following common ideals or principles, which are found throughout the EBM literature:

- EBM is **place-based**, focusing on a specific ecosystem and the range of activities affecting it, including physical and biological processes, and human activities.
- EBM emphasizes the **protection of ecosystem structure, functioning, and key processes** based on science.
- EBM explicitly accounts for the **interconnectedness within systems**, recognizing the importance of interactions among many target species or key services and other non-target species.
- EBM addresses the **interconnectedness among environments**, such as air, land and sea.
- EBM aims to **integrate ecological, social, economic, and institutional perspectives**, recognizing their strong interdependence and mutual influences.
- EBM considers important interactions and relationships among components of the social system and addresses management sectors, thus emphasizing the need for **collaborative governance processes**.

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[23] This statement was signed by 219 academic scientists and policy experts with relevant expertise and published by COMPASS. See McLeod et al. 2005. *Scientific Consensus Statement on Marine Ecosystem-Based Management.* http://compassonline.org/?q=EBM

[24] COMPASS has also released a consensus statement on Marine Reserves. These types of broad agreements from the academic and scientific community aim to serve as the beginnings of standard agreements or principles for policy making.

[25] This idea was well supported by a 2-day meeting in January 2008 at the University of Santa Cruz, hosted by the California Current Ecosystem-Based Management initiative (CCEBM). Participants with expertise in natural and social science, management and policy agreed we are moving beyond defining EBM. Discussions focused on how to apply science to the implementation of EBM, rather than on what EBM means or why we need to apply this approach.

Along with these six ideals or principles, four others are necessary to highlight:

1. **EBM expressly manages human behavior as part of the ecosystem.** EBM is by its very nature about interactions and connectivity: those between land and sea; people and the environment; among stakeholders, managers and scientists; and among different spatial and temporal scales.[26] EBM explicitly recognizes these critical interactions, and that humans are an integral part of the ecosystem, as opposed to operating outside of it. EBM recognizes that: (1) humans cannot control or manipulate entire ecosystems; and (2) because humans are a significant part of ecosystems, policy, regulations, and management must take a long-term and socioeconomic view to address the ways by which human activities and ecosystems impact each other.[27]

2. **EBM plans for long-term ecosystem functioning.** EBM includes the idea of sustainability of resources, and the focus on long-term functioning of ecosystems in acceptable states or conditions. Planning horizons should account for multiple political turnovers and variations in social values. Providing for long-term functioning, process and structure of ecosystems could include monitoring programs to understand slow ecosystem changes over successive political administrations, and through the use of historical data sets for decision-making.[28]

3. **EBM incorporates adaptive management.** Most environmental plans and projects have the underpinnings of a new paradigm and follow a pattern: "predict, mitigate, implement, monitor, and adapt."[29] EBM works by using the best scientific understanding of how ecosystems function across a wide continuum of scales and scope, yet it allows efforts to move forward when uncertainty of science becomes a roadblock. Providing for flexibility in project implementation is especially valuable for EBM and climate change adaptation because of the need to account for a wide variety of uses, activities, and resources throughout a specific region that are inherently difficult to manage and tend to be dynamic in space, time and nature.[30]

4. **EBM calls for the sustained provision of ecosystem services.** Scientists recognize four categories of ecosystem services: provisioning services (e.g., seafood, sand); regulating services (e.g., water quality, storm protection); cultural services (e.g., recreational, spiritual, and other non-material benefits); and supporting services (e.g., nutrient cycling, photosynthesis). Ecosystem services are distinct from other ecosystem functions and products because there is an explicit human demand for these natural amenities. Transitioning toward EBM requires key services in a particular place to be determined, the spatial distribution of these services to be mapped, and the range of factors affecting their production and delivery to be better understood.[31]

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[26] Heiman, K., and Dean Wendt. 2006. *Connecting the many scales of marine EBM,* in The Evolution of Ecosystem Based Management: From Theory to Practice. Proceedings from the 6th Marine Law Symposium, Roger Williams University School of Law.
[27] Andrew Rosenberg and Karen McLeod. 2005. *Implementing ecosystem-based approaches to management for the conservation of ecosystem services.* Marine Ecology Progress Series, Vol. 300, pp. 270-274.
[28] Environmental Law Institute. July 2007. Ecosystem-based management: Laws and Institutions. Ocean Program. See http://www.eli.org/Program_Areas/ocean_ebm.cfm
[29] See Baur et al. 2008. *Legal Authorities for Ecosystem Based Management in U.S. Coastal and Ocean Areas,* in Ocean and Coastal Law and Policy. American Bar Association.
[30] *Id.*
[31] This was a key mission of the California Current Ecosystem-Based Management Initiative (CCEBM). The CCEBM is a joint effort between the Communication Partnership for Science and the Sea (COMPASS) and the Institute of Marine Sciences at the University of California, Santa Cruz. See http://ims.ucsc.edu/CCEBM/public_detailspage.html

Figure 2 depicts: (A) a consideration of interactions among policies, without negating the need for individual sector management; (B) examination of interactions among the impacts of individual sectors as well as the cumulative impacts of individual and multiple sectors through time; (C) monitoring the effects of these cumulative impacts on ecosystem structure, functioning and key processes, as well as the way in which reciprocal changes to ecosystems modify those impacts; and (D) the goal of EBM as to maintain the flows of key ecosystem services that result from ecosystem structure, functioning, and processes.[32]

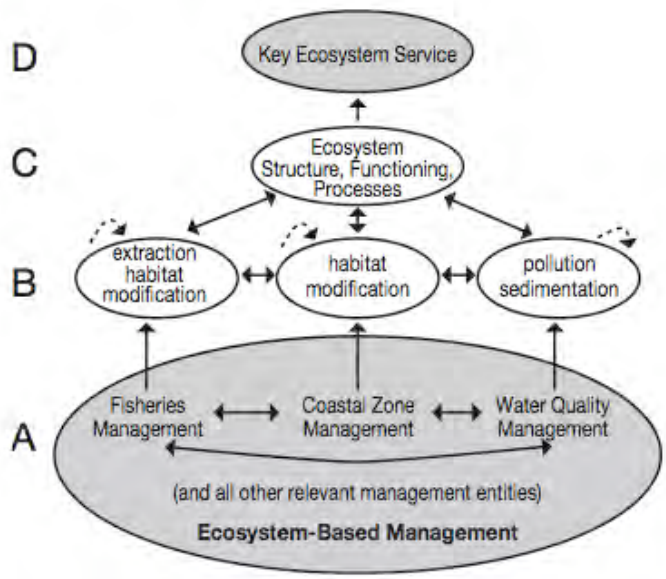

Figure 2. The process of providing and ensuring in the long-term, key ecosystem services. Source: Rosenberg and McLeod. 2005.

Ecosystem-Based Elements

The EBM umbrella also contains core ecosystem-based elements. These are larger place-based management practices comprised of the principles mentioned above, and which will be discussed in more detail as they relate to the Bay Area in Chapter 5.

Marine Spatial Planning with Comprehensive Zoning (MSP). In its broadest sense, MSP is about analyzing and allocating parts of the three-dimensional marine space to specific uses to achieve ecological, economic, and social objectives that are usually specified through the political process.[33] In addition, MSP is a process for regulating, managing and protecting the marine environment that addresses the multiple, cumulative, and potentially conflicting uses of the sea.[34] Essentially this is a logical evolution of present coastal and marine management efforts, and a concept that's being recommended by experts such as Dr. Jane Lubchenco,

[32] Rosenberg and McLeod. 2005. *Implementing ecosystem-based approaches to management for the conservation of ecosystem services.* Marine Ecology Progress Series.
[33] Charles Ehler and Fanny Douvere. *Visions for a Sea Change: Report of the First International Workshop on MSP*. Intergovernmental Oceanographic Commission and Man and the Biosphere Programme. IOC Manual and Guides No. 48, IOCAM Dossier No. 4. Paris: UNESCO, 2007.
[34] See Department for Environment, Food, and Rural Affairs (Defra), 2007. *A Sea Change: a Marine Bill White Paper*. Marine Legislation Division. London, 176 p.

recently appointed as the Administrator of NOAA.[35] Traditionally, most marine conservation planning and zoning has been ad hoc, coming together bit by bit as individuals, communities, and institutions respond to a particular need at a particular site—restricting access to a threatened coral reef system, for example, or regulating harvest of a depleted fish stock. Examples of these marine protected areas (MPAs) stretch the gamut from wildlife refuges to national marine sanctuaries. Although well intentioned, such responses are usually far too focused to address the multiple threats that cumulatively affect the targeted impact and simultaneously degrade most of the world's nearshore ecosystems.[36]

Comprehensive zoning is a method for connecting – and filling in the spaces between – these separate and disconnected marine protected areas into a more holistic management area. It aims to codify the MSP process by developing specific zone types with associated allowed, permitted, and prohibited human uses and activities, and it has a number of benefits. Zoning can aid the assessment and management of cumulative impacts, organize the marine space for greater ecosystem service assurance through trend tracking and potential modifications, reduces conflicts, and succeed in giving mitigation efforts a wider net.

Integrated Watershed Management (IWM). IWM is a planning concept developed to reconcile competing uses that degrade watersheds. It aims to meet multiple objectives across large spatial scales by coordinating the actions of numerous communities and user groups.[37] Some primary goals of integrated watershed management are to provide adequate freshwater flow for ecosystem and human needs, maintain healthy riparian habitat and good water quality, and mitigate past and future watershed impacts. Most efforts assure the creation of a plan of action, which typically reflects a set of common goals that meet the needs of the watershed community and the larger ecosystem. In general, a number of communities have flood management plans that are place-based, and could be expanded to include ecosystem protection and sediment management as well. New modeling tools are helping link watersheds and water bodies. For example, efforts are underway to project how a particular land use (wharf, parking lot, power plant, restaurant, etc.) will impair a particular water body: such as by what and how much of a particular contaminant is likely to be added. IWM is increasingly important to adapting to climate change, in terms of ensuring adequate sediment flows from creeks, streams, and rivers to enable upland wetland transgression.

Ecosystem-Based Tools

EBM also incorporates an ever-expanding collection of *tools* that can support the aims of, and the decisions necessary for, these larger ecosystem-based elements. EBM requires a wide variety of potential tools and approaches because of its place-based, comprehensive, and adaptive nature. EBM tools are software or web-based computer programs, or other technologies that can help implement EBM by: (1) providing models of ecosystems or key ecosystem processes; (2) generating scenarios illustrating the consequences of different management decisions on natural resources and the economy; and (3) facilitating stakeholder involvement in planning processes.[38] These include scientific tools such as integrated

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[35] Juliet Eilperin. May 4, 2009. "Finding Space for All in our Crowded Seas," in The Washington Post.
[36] Most MPAs were, and continue to be, born of a fishing nature: the need to protect habitat for fish, or to minimize fishing take, etc. See Tundi Agardi. 2009. "A Separate Peace" in *10 Ways to Save the Oceans*. Conservation Magazine. A Publication of the Society for Conservation Biology.
[37] See Marine Ecosystems and Management (MEAM). June-August 2008. Vol. 1, No. 4. Retrieved from www.meam.net
[38] The EBM Tools Network houses an extraordinary level of the latest tools and technologies available for users. EBM tools include data collection and management tools; data processing tools; conceptual modeling tools; modeling and analysis tools (such as watershed models, marine ecosystem models, dispersal models, habitat models, socioeconomic models, and model development tools); scenario visualization tools; decision support tools (such as coastal zone management tools, fisheries management tools, conservation and restoration site selection tools, land use planning tools, and hazard assessment

socioeconomic-ecological models, geographic information systems (GIS), and specialized software that can allow managers to examine alternate configurations for marine protected areas or other ocean zones.[39] Some tools also complement certain ecosystem-based principles, such as cumulative impact assessments and regional ocean observing systems.[40]

Cumulative Impact Assessment Frameworks. Until recently, the science of analyzing cumulative impacts from human uses and activities lagged far behind the desire of policymakers to incorporate these critical components into plans and policies. Within the last few years, a framework has been developed by scientists at the University of California Santa Barbara that lays out a methodology for quantifying cumulative impacts. An example application of this framework is the use of land-based pollution intensity and distribution data in local- and regional-scale water quality management. In addition, the cumulative impact maps developed through this assessment framework can provide guidance on where conservation action may be most critical (e.g. last remaining low-impact areas), where mitigation of key stressors is most needed, and where various activities are compatible.[41]

Ocean Observing Systems. The need for real-time ocean observance and data products is great and rapidly increasing.[42] Ocean observance uses various sensing technologies to add to our knowledge of changing ocean conditions and to enhance coastal management, allowing for more informed decision-making. The federal Integrated Ocean Observing System (IOOS) was established as a multidisciplinary system designed to enhance our ability to collect, deliver, and use ocean information.[43] The goal is to provide continuous data on our open oceans, coastal waters, and Great Lakes in the formats, rates, and scales required by scientists, managers, businesses, governments, and the public to support research and inform decision-making.

The EBM Pathway

While it is true that some of the components underneath the EBM umbrella have been used in the past, newer components, like MSP and cumulative impact frameworks, are now available to be used to inform sound policy and management decisions. By conceptualizing EBM as an umbrella approach and visualizing it as a collection of elements, principles, and tools, management entities can pick and choose and use those components they require.

By using these various EBM components, these same entities can avoid hesitating over vagueness of definition or confusion over how best to implement EBM, and instead recognize that EBM is a pathway toward broader implementation of ecosystem approaches to management. Finally, a focus on ensuring ecosystem services rather than on EBM *per se* allows entities to manage in a way that optimizes the provision of multiple ecosystem services, not just within a single human use or activity, but also across and among them.

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and resilience planning tools); project management tools; stakeholder communication and engagement tools; and monitoring and assessment tools. See www.www.ebmtools.org for more.

[39] Carrie V. Kappel et al. 2006. "Ecosystem-based management." In: Encyclopedia of Earth. Eds. Cutler J. Cleveland (Washington, D.C.: Environmental Information Coalition, National Council for Science and the Environment). [Published in the Encyclopedia of Earth October 4, 2006; Retrieved May 2, 2009]

[40] In other words, while the incorporation of cumulative impact assessment and management is an EBM principle, the actual tool that can aid this process is the framework, which quantifies the impacts. Similarly, ocean observing for a specific area is a principle, yet the technical system is the tool.

[41] Halpern et al. 2009. *Mapping cumulative human impacts to California Current marine ecosystems*. Conservation Letters, pp. 1-11.

[42] For more on Integrated Ocean Observing Systems (IOOS), see http://ioos.gov

[43] For more on IOOS and the regional Central and Northern California Ocean Observing System (CeNCOOS), see http://www.cencoos.org/sections/about/about.shtml

CHAPTER 3

IMPLEMENTING ECOSYSTEM-BASED MANAGEMENT: LAWS AND PRACTICES

A call for the use of a broader ecosystem approach to marine management came in 1993 when the Congressional Research Service (CRS) issued a report on the scientific basis for marine ecosystem management.[44] The report implicated a wide range of threats including, overexploitation of fish stocks or resources, habitat destruction, declining water quality, introduction of exotic species and global climate change, to the viability of marine resources and observed that these threats are not isolated. Together they have the potential to affect the biological, chemical, and physical foundation of these resources. The report also recognized the variability in natural systems and that their potential effects (e.g. disease epidemics, predator infestations, periodic climate shifts like El Nino) are magnified by the stresses from human impacts. Most significantly, the report addressed the core issue coastal managers are still trying to confront: While management systems exist to address many of these threats independently, the unanswered question is whether it is possible to respond to several or all threats at once.

EBM Legislation and Status

On a national level, a number of current proposals have been issued to help implement EBM. The Pew Oceans Commission (Pew Report) and the U.S. Commission on Ocean Policy (USCOP) were the first to focused on the crisis facing America's oceans and issued recommendations for a new ocean policy. The Pew Report, *America's Living Oceans: Charting a Course for Sea Change,* proposes a unified national ocean policy to: (1) encourage comprehensive and coordinated governance of the ocean resources and uses; (2) restructure fishery management institutions and reorient policy to focus and protect ecosystems; (3) protect important habitat and manage coastal development; and (4) control sources of pollution. The Pew Report found a lack of adequate mechanisms for EBM coupled with fragmented and ineffective management due to the existence of over 140 federal laws and dozens of federal agencies involved in ocean administration. To overcome this, the Pew Report recommended enacting a National Ocean Policy Act (NOPA) to create regional ecosystem councils, responsible for implementing EBM by developing and overseeing the implementation of regional ocean governance plans. These councils would include a host of federal, state, and tribal authorities. The plans would include federal consistency mechanisms similar to those in the Coastal Zone Management Act, and be fully enforceable against all parties. Together, NOPA, the ecosystem councils, and the regional plans, would promote coordination among different levels of government and lead to an EBM approach.

The USCOP Report, *An Ocean Blueprint for the 21st Century*, issued almost a year and a half after the Pew Report, came to many of the same conclusions and recommendations. These included the lack of coordination amongst all levels of governmental agencies that has led to ineffective governance and the recommendations to: (1) create regional ocean councils to facilitate coordinated responses to regional issues; (2) develop regional goals and objectives; and (3) communicate regional concerns through a newly created National Ocean Council within the Executive Office of the President.

The U.S. Ocean Action Plan – former President George Bush's response to the recommendations of the USCOP report – was established in December 2004 by Executive Order. The Ocean Action Plan establishes the Committee on Ocean Policy, a Cabinet–level committee "to advise the president and, as appropriate, agency heads on the establishment and

[44] Eugene H. Buck. 1993. *CRS Report for Congress: Marine Ecosystem Management*. Congressional Research Service.

implementation of policies concerning ocean related matters."[45] However, while the Ocean Action Plan takes some steps toward fulfilling the USCOP's recommendations on coordination, integration, structure, and science, it makes only very limited references to ecosystem issues or services, and does not require any concrete or specific steps toward EBM.[46]

Since 2004, several bills have been introduced containing EBM language and several are working their way through Congress. Most notably, the Oceans Conservation, Education, and National Strategy for the 21st Century Act (OCEANS-21), provides the necessary tools for the government to make comprehensive decisions on marine issues. OCEANS-21 would establish a national ocean policy to protect, maintain and restore the health of ocean ecosystems and requires that each federal agency administer U.S. policies and federal laws to the fullest extent possible consistent with this policy. It establishes Regional Ocean Partnerships around the country to promote ecosystem-based management and coordination among federal, state, and local governments. It is both focused on long-term sustainability and based on securing ecosystems services. The goal of OCEANS-21 is to "secure for present and future generations of people of the United States, the full range of ecological, economic, educational, social, cultural, nutritional, and recreational benefits of healthy marine ecosystems."[47] Significantly and uniquely, it would do so in part by "promoting ecosystem-based approaches to management of ocean waters and resources."[48]

The Joint Ocean Commission Initiative (JOCI), a collaborative effort among representatives from both the Pew Commission and USCOP, has endorsed EBM. NOAA's Strategic Plan includes the goal to, "Protect, restore, and manage the use of coastal and ocean resources through an ecosystem approach to management."[49] On July 12, 2009, President Obama called for a scientific and ecosystem-based approach to management to be used in the management of the Nation's oceans and coastal environments.[50] The states of New York, Florida, Hawaii, New Jersey, and California have all legislatively adopted EBM as the foundation to help conserve and protect their respective coastal ecosystems through the creation of coastal and ocean resource protection councils.

Concurrently, the concept of EBM has been well received on the international stage. This stems from a singular major factor: increasing awareness of the cumulative impacts of industrial activities on the ecosystem and the impacts of these activities on numerous fisheries around the world. The 1992 UN Conference on Environment and Development (UNCED) pioneered the movement ushering in a conceptual switch to a more holistic and integrated management approach.[51] Further conferences and conventions highlighted the need for resource management to be considered within a broader biological and socioeconomic context, including the UN Convention on Biological Diversity in 2000. More recently, the Millennium Ecosystem Assessment (2005), a five-year effort involving over 1300 scientists from 95 countries, confirmed the importance of using ecosystem approaches to management to protect and maintain the delivery of vital ecosystem services.[52] The United Nation's International Maritime Organization (IMO), and Food and Agriculture Organization (FA) both use EBM as cornerstones of their programs. Canada's Ocean Act of 1997 announced Canada's adoption of a holistic approach to

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[45] U.S. Ocean Action Plan: the Bush Administration's Response to USCOP (2004), available at http://ocean.ceq.gov/actionplan.pdf
[46] Ocean and Coastal Law and Policy, *supra* note 28.
[47] Oceans Conservation, Education, and National Strategy for the 21st Century Act, H.R. 21, 110th Congress (2007)
[48] *Id.* § 3(6).
[49] See NOAA, *New Priorities for the 21st Century: NOAA's Strategic Plan*. FY 2009 - FY 2014
[50] Barack Obama, Presidential Proclamation and Memorandum, June 12th, 2009 as part of National Oceans Month.
[51] However, a fundamental description of the basis for an 'ecosystem approach' was first formalized in the Stockholm Declaration in 1972. See, W.R. Turrell. 2004. *The policy basis of the ecosystem approach' to fisheries management*. EuroGOOS Publication No. 21.
[52] For more information on the Millennium Ecosystem Assessment (2005), see www.MAweb.org

the management of its aquatic ecosystems, which includes an integrated framework designed to consider the impacts of diverse oceans industries.[53] Australia is arguably at the forefront of national ecosystem-based marine spatial planning through the creation of the Great Barrier Reef National Marine Park and other regional efforts.

These reports and subsequent bills indicate what is generally known in the marine and coastal fields: that existing law in the United States does not provide any single or comprehensive source of authority for establishing an EBM program for the marine environment.[54]

Existing Federal EBM Laws

There is, however, the real potential to apply existing law to implement EBM. Several national laws standout as top candidates and can be more comprehensively applied to the Bay Area. Following this section, a number of EBM efforts currently underway in California and along the U.S. West Coast will be discussed which have policy and management implications for the Bay Area.

The Coastal Zone Management Act (CZMA) is perhaps the most applicable law currently available to provide a legal framework for implementing broader ecosystem approaches to management.[55] In its current form, the CZMA includes many concepts that are essential to EBM, and a pending reauthorization to the Act could open the door for additional opportunities. A report by the Environmental Law Institute (ELI) highlighted several key changes to the Act that would advance EBM while preserving its federal-state structure and the incentives that have made this voluntary program enticing to so many states.[56]

According to the ELI, to produce more effective coastal management programs, the Act should: (1) require ecosystem assessments and support the means for their completion; (2) require the development of state coastal zone plans based upon ecosystem assessments; (3) update statutory definitions to consider the ecological boundaries of the inland coastal zone, and explicitly recognize conservation as an acceptable human use; (4) require a more integrated management approach through interstate collaboration and consistency, assessment of cumulative impacts, and establishment of mechanism to make tradeoffs among competing or conflicting uses; (5) further develop the special area management program to incorporate EBM principles and be more widely used; and (6) encourage greater state use of its federal consistency authority.[57]

While the CZMA does not have specifically enforceable EBM provisions, § 1452-Declaration of Policy (2)(J) supports comprehensive planning, conservation, and management for living marine resources as well as improved coordination between State and Federal coastal zone management agencies and State and wildlife agencies.[58] BCDC, as a state agency under the CZMA, can take advantage of this funding opportunity and engage in collaborative efforts regarding marine spatial planning, integrated watershed management, or cumulative impact assessment and management.

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[53] O'Boyle, R. and Glen Jamieson. 2006. *Observations on the implementation of ecosystem –based management: Experiences on Canada's east and west coasts.* Fisheries Research, Vol. 79, 1-12.
[54] Ocean and Coastal Law and Policy, *supra* note 28.
[55] ELI, *supra* note 27.
[56] Environmental Law Institute. 2009. *Expanding the Use of Ecosystem-Based Management in the Coastal Zone Management Act*.
[57] *Id.*
[58] *Id.*

The Marine Mammal Protection Act (MMPA), which was enacted in 1972 to address problems confronting certain marine mammals and population stocks, also contains avenues to implement EBM.[59] With the amendments in 1994, the MMPA became the first Act in which Congress had acknowledged that ecosystem-based recommendations, rather than single-species population goals, should be the focus of federal action under a law concerned with ocean resources. These amendments required the use of an EBM approach for scientific research in the Bering Sea,[60] as well as a regional workshop to be carried out to assess "human-caused factors" affecting the health and stability of the Gulf of Maine.[61] In addition, Section 112 of the MMPA authorizes the Secretary of Commerce to protect not only the mammals themselves, but also their habitat under the primary management objective of the MMPA – to maintain the health and stability of the marine ecosystem. Considering the wide range of harbor seals, sea lions, harbor porpoises, and other marine mammals within San Francisco Bay, this legal authority could be useful in promulgating regulations to protect the marine ecosystem as a whole.

The federal Endangered Species Act (ESA) of 1973 has a stated purpose of "provid[ing] a means whereby the ecosystems upon which endangered… and threatened species depend may be conserved."[62] Although the focus for almost 20 years was on the protection of individual species, Interior Secretary Bruce Babbitt championed several reforms to the Act. One reform stated that the Act should include "a greater emphasis on ecosystem-level management of habitat and other resources."[63] Spurred by this and other reforms and the emergence of conservation biology as an influential body of applied science, a number of multispecies conservation plans and programs have been initiated in both the public and private sectors.[64] Several aspects of the federal ESA lend themselves well to the implementation of ecosystem-based approaches to management in the Bay Area.

The creation of a habitat conservation plan (HCPs) is one such avenue. HCPs are popular agreements that private landowners develop to manage endangered species on their property. HCPs can be applied on a multispecies or even ecosystem-based scale and have proven to be successful nationally.[65] In fact, the idea of habitat conservation plans started on San Bruno Mountain, near San Francisco, where the discovery of two endangered butterflies stopped a proposed development plan.[66] HCPs have been used to authorize activities under state law and could be adapted to state fishery or coastal zone programs. Today, several HCPs are greater than 1,000,000 acres, where once they were primarily for planning areas of less than 1,000 acres.

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[59] Marine Mammal Protection Act Amendments of 1994, Pub. L. No. 92-522, 86 State 1027 (codified at 16 U.S.C. §§ 1361-1421).
[60] Marine Mammal Protection Act Amendments of 1994, Pub. L. No. 103-238, §7, 108 Stat. 532, 561 (codified at 16 U.S.C. §1380(d)(1)).
[61] *Id.*
[62] The California ESA will not be described separately as it shares the same purpose and similar regulations of the federal version. See the Endangered Species Act of 1973, Pub. L. No. 93-205, 87 Stat. 884 (codified as amended at 16 U.S.C. § 1531 et seq.).
[63] See J.B. Ruhl. 2004. *Endangered Species Act Innovations in the Post-Babbittonian Era-Are There Any?* Duke Environmental Law and Policy, 14, 419-430.
[64] Ocean and Coastal Law and Policy, *supra* note 28.
[65] *Id.*
[66] Robert McClure and Lisa Stiffler. May 3, 2005. *A License to Kill: Flaws in habitat conservation plans threaten scores of species.* Seattle Post Intelligencer.

This suggests that HCPs are evolving from a process adopted primarily to address single projects to broad-based, landscape-level planning, utilized to achieve long-term biological and regulatory goals.[67] In the Bay Area, HCPs can be used to conserve habitat important to marine species, such as the endangered salmon or other anadromous fish. The ESA could also be used to support marine spatial planning and zoning through both the take prohibition in Section 9[68] and through the designation of critical habitat.[69]

The Magnuson-Stevens Fishery Conservation and Management Act (FCMA) originally enacted in 1976 did not expressly provide for EBM or ecosystem considerations. Instead it focused largely on the management of individual species. Yet its reauthorization in 1996 began the transition to a more ecosystem based perspective with requirements of the eight regional management councils to identify essential fish habitat (EFH), take measures to protect it, and to determine the effects of fishing on the environment.[70] In 2006, the Bush Administration reauthorized the Act amending the FCMA to state that, "[a] number of the Fishery Management Councils have demonstrated significant progress in integrating ecosystem considerations in fisheries management using the existing authorities provided under this Act."[71] Additionally, plans analyzing cumulative impacts "must analyze the likely effects, if any, including the cumulative conservation, economic, and social impacts, of the conservation and management measures on, and possible mitigation measures.[72] Today, this is often referred to as ecosystem-based fishery management (EBFM) – sometimes referred to as an ecosystem approach to fisheries (EAF) – which is a subset of EBM focused on fisheries. The broad purpose of EBFM is to plan, develop, and manage fisheries in a manner that addresses the multiple needs and desires of societies, without jeopardizing the options for future generations to benefit from the full range of goods and services provided by marine ecosystems.[73]

The federal Clean Water Act is argued by some authors to have the greatest potential to support EBM components of any federal pollution control statute, based on its Total Maximum Daily Allowance approach to pollutants.[74] While the use of TMDLs are not without controversy, they are based on a specified geographic area, usually an entire watershed, which lends itself well to integrated watershed management programs in the Bay Area as well as moving toward more comprehensive land-to-sea planning efforts.

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[67] For more information about Habitat Conservation Plans and Incidental Take Permits see http://www.defenders.org/programs_and_policy/habitat_conservation/private_lands/habitat_conservation_plans.php and www.fws.gov/Endangered/pdfs/HCP/HCP_Incidental_Take.pdf

[68] Such as the rerouting of ships away from areas where whale's congregate, specifically the North Atlantic right whale off the coast of Boston. For more information, see *Endangered Fish and Wildlife; Proposed Rule to Implement Speed Restrictions to Reduce the Threat of Ship Collisions with North Atlantic Right Whales*. (2006) 71 Federal Register 36, 299.

[69] Such as closing areas of commercial fishing and reducing allowable catch of prey species, in order to maintain an adequate "carrying capacity" of forage fish to meet the nutritional needs of the Steller sea lion in the Gulf of Alaska and the Bering Sea. For more information see NOAA Fisheries, Steller Sea Lions found online at: http://www.fakr.noaa.gov/protectedresources/stellers/default.htm

[70] Ocean and Coastal Law and Policy, *supra* note 28.

[71] Magnuson-Stevens Fishery Conservation and Management Reauthorization Act of 2006, Pub. L. No. 109-479, 120 Stat. 3575 (2007).

[72] Ocean and Coastal Law and Policy, *supra* note 28.

[73] FAO. 2003. "Fisheries Management 2: The Ecosystem Approach to Fisheries." FAO, Rome.

[74] The California Clean Water Act will not be described as it shares the same purpose and similar regulations as the federal version. See the federal Clean Water Act at http://www.epa.gov/water/laws.html.

The National Environmental Policy Act (NEPA), while advocating a goal of achieving a world "where man and nature can exist in productive harmony," has little explicit call for the use of EBM components beyond being "ecologically minded."[75] However, NEPA has helped push some EBM principles toward the mainstream, including calling for an interdisciplinary approach to decision making (Section 102) based on obtaining adequate environmental data, and the power of adaptive management. NEPA requires cumulative impact assessments of projects and require addressing them. However, NEPA does not require federal agencies to manage for their impacts.

California EBM Efforts

Within California law, there are a number of significant existing statutes related to marine and coastal management that specifically address ecosystem-based approaches to management and have broad implications for BCDC.

The California Ocean Protection Act of 2004 (COPA) recognizes that preservation of the state's marine resources depends upon "healthy, productive, and resilient ecosystems" and that "governance of ocean resources should be guided by principles of sustainability [and] ecosystem health."[76] COPA strongly affirms "the state's policy to incorporate ecosystem perspectives into the management of coastal and ocean resources, using sound science… rather than managing on a single species or single resource basis."[77] In adopting COPA, the Legislature specifically identified the pressing need to "integrate and coordinate the state's laws and institutions responsible for protecting and conserving ocean resources" and called for "a set of guiding principles for all state agencies to follow… in protecting the state's coastal and ocean resources."[78] Additionally, the Legislature recognized that "the ocean ecosystem is inextricably linked to activities on land and all public agencies should consider the impact of activities on land that may adversely affect the health of the coastal and ocean environment." COPA also mandated the establishment of the Ocean Protection Council (OPC) to help coordinate state policy for the conservation of coastal waters and marine ecosystems.[79]

The Marine Life Protection Act (MLPA) of 1999 requires that the California Department of Fish and Game establish networks of marine protected areas (MPAs) in state waters. MPAs consist of national refuge areas, marine sanctuaries, conservation areas, and reserves, which are subject to specific legal requirements.[80] The challenge in incorporating these areas into an ecosystem-based approach to management is linking them together in a coordinated and comprehensive system.[81] Another challenge stems from the threat of climate change and its potential impacts on the nature and function of our oceans, and its species compositions and patterns. MPA experts and designers are now reevaluating MPA size and location parameters to better ensure protection for habitats and fisheries in the future.[82]

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[75] National Environmental Protection Act. 42 U.S.C § 4331
[76] See the California Ocean Protection Act (2004)
[77] *Id.*
[78] *Id.*
[79] Since February 2007, the California Ocean Science Trust, established by the California Ocean Resources Stewardship Act of 2000 to ensure that the best science is applied to California policies and ocean management, has provided science services to the OPC.
[80] The federal MPA Executive Order, establishing a unified classification of MPAs in the United States, provides numerous provisions for identifying the importance of protecting marine ecosystems and basing federal actions on ecosystem functions. In reality however, implementation of the Order has been slow and coordination has been lacking in terms of systematically emphasizing EBM and connecting individual MPA conservation mandates and EBM objectives in a coordinated manner.
[81] *Id.*
[82] Dr. Mark Carr (UCSC) and Dr. Charlie Wahle (MLPA). April 10, 2009. Presentation at Stanford Law School's Climate Change Conference.

Two of the goals of the MLPA specifically address ecosystem protection and ecosystem approaches to management to: 1) "protect the natural diversity and abundance of marine life, and the structure, function, and integrity of marine ecosystems;" and 2) improve recreational, educational and study opportunities provided by marine ecosystems that are subject to minimal human disturbance, and to manage these uses in a manner consistent with protecting diversity."[83] The MLPA also lays out an explicit call for adaptive management by stating, "actions shall be designed so that, even if they fail, they will provide useful information for future actions, and monitoring and evaluation shall be emphasized so that the interaction of different elements within marine systems may be better understood."[84] San Francisco Bay is designated to be the final piece of the MLPA puzzle and will likely see an MPA effort in 2011.

Section IX "Land Use and Planning" of the California Environmental Quality Act (CEQA) requires an agency to evaluate the consistency of a proposed development project with policies contained in any applicable "land use plan, policy or regulation of any agency with jurisdiction over the project..." This language could potentially and properly be interpreted to include within its scope BCDC's San Francisco Bay Plan – which will be shown below to contain numerous references to several EBM components – and thus must be taken into account in any CEQA review that is subject to the BCDC's regulatory jurisdiction. CEQA and the CEQA Guidelines address cumulative impacts, defined in section 15355, through their listing as a "mandatory finding of significance" in § XVII(b) of Appendix G, and are extensively discussed in CG § 15130. Collaborative governance is also implicit in the CEQA's and the CEQA Guideline's extensive intergovernmental notice and consultation requirements.[85]

Regional EBM Efforts

A number of efforts on a regional level are utilizing EBM components. For example, the West Coast Governor's Agreement on Ocean Health (WCGA) is a joint interstate collaborative effort among California, Oregon and Washington to better manage the coastal and ocean environments on a regional level. The statutory purpose is to reverse declining health of ocean ecosystems by launching a collaborative effort to protect ecosystems. Specific EBM language includes, "As the USCOP and Pew acknowledged in their reports on the status of the ocean, improved coordination among governing bodies is needed, and oceans should be managed on an ecosystem level." Recently, the WCGA released Sea Grant's West Coast Regional Marine Research Report, to guide the development of priorities for regional initiatives and investments in natural and social science research[86]

The California Current Ecosystem-Based Management initiative (CCEBM) was a collaborative effort between the University of California, Santa Cruz and the Communication Partnership for Science and the Sea (COMPASS), which provided an opportunity to assess and advance the science needed for comprehensive EBM along the U.S. West Coast and within the California Current.[87] This endeavor sought to prepare key pieces of research, assuming that all necessary political, management and legal structures are in place to achieve desired ecosystem goals. Although EBM is likely to be achieved through both incremental steps and more overarching changes to current institutional frameworks, the CCEBM initiative was an opportunity to be forward thinking, and as such, has laid the foundation for progressive thinking about how to advance scientifically informed EBM.[88]

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[83] *Id.*
[84] *Id.*
[85] For more information on the California Environmental Quality Act see http://ceres.ca.gov/ceqa/
[86] The final report is available for download at http://seagrant.oregonstate.edu/research/RegionalPlanning/index.html
[87] The California Current is one of 64 Large Marine Ecosystems (LMEs) designated around the world.
[88] CCEBM, *supra* at 30.

Another example of regional EBM efforts is the West Coast EBM Network. This collaboration of six groups and regions in California and Oregon implementing ecosystem-based approaches to management provides an avenue for sharing experiences, tools, and information. The idea behind the EBM Network is that in order to successfully implement broader EBM, resource managers need opportunities to learn from each other, to understand what tools and information exist to aid them, to find ways to connect stakeholders and partners in their region and to address conflicts among them.[89] While the project is a two-year effort, great strides have been made to connect the many scales of EBM, from small bays and estuaries to larger community-based efforts of the National Estuary Program, to the offshore environments of the CCEBM.

Adaptive management is a key component of EBM. Adaptive management is now a fundamental part of many efforts throughout the region, which recognizes the dynamic nature of ecosystem function and climate change. Several examples of adaptive management are worthy of highlighting. These programs have expressly instituted adaptive management into their plans, which include specific and measurable goals, updating regional plans on a regular schedule based on a review of previous achievements, continuous monitoring, and communicating results to the public. Perhaps the most comprehensive effort is part of the South Bay Salt Pond Restoration Project (SBSP), which devotes 143-pages to its adaptive management plan.[90] Crafted by Dr. Lynne Trulio and members of the SBSP Science Team, the plan was created to help guide the planning and implementation of each project of its restoration plan, expressly recognizing that "adaptive management provides a directed approach to achieving the Project objectives though learning from restoration and management actions – actions for which many scientific and social uncertainties exist."[91]

Additionally, the Bay Delta Conservation Plan (BDCP) has an adaptive management section within its Conservation Strategy and states as one of its six planning principles to "Address Scientific Uncertainty Directly Through Adaptive Management." This is to ensure the continuous input of data, knowledge, and up-to-date scientific information to enhance the efficacy of the BDCP conservation measures and increase their capacity to meet the goals and objectives of the plan.[92] Currently, state and federal agencies are developing a joint environmental impact report/statement (EIR/S) to determine the environmental impacts of the BDCP.

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[89] For more information see the West Coast EBM Network's Draft Concept Paper and more online at www.westcoastEBM.org

[90] Dr. Lynne Trulio, (lead author). November 14, 2007. SBSP Adaptive Management Plan. Science Team Report.

[91] *Id.*

[92] Department of Water Resources. An Overview of the Draft Conservation Strategy for the Bay Delta Conservation Plan. December 17, 2008. BDCP Steering Committee.

CHAPTER 4

THE SAN FRANCISCO BAY CONSERVATION AND DEVELOPMENT COMMISSION AND GOVERNANCE

As Chapter 3 described, there is a suite of existing legislation that support the use of ecosystem-based approaches to management, and a number of programs seeking broader EBM implementation in California and on the west coast of the United States. BCDC has the legal foundation to begin implementing ecosystem-based approaches to management under the agency's guiding policy and management documents, yet will need to strengthen its position on newer EBM components in order to move toward broader implementation of EBM. Additionally, several governance obstacles exist that limit the ability of BCDC to advance upon its collaborative approach. Fortunately, a number of opportunities and solutions are evident to overcome them.

The McAteer-Petris Act and the San Francisco Bay Plan

A detailed analysis of BCDC's guiding documents reveal several EBM components, including long-term ecological planning, place-based management, collaborative interagency efforts, interconnectedness among environments (land, water, and air), monitoring and review, ecosystem protection, and the requirement for the use of strong science.

The McAteer-Petris Act, as amended 1965, created BCDC and required the Commission to engage in a three-year effort to create a comprehensive and enforceable management plan to guide development and ensure conservation of the San Francisco Bay's natural resources.[93] When this was completed in 1968 and approved by the Legislature, the Act was revised and amended to incorporate the findings and policies of the Bay Plan.

The McAteer-Petris Act contains several passages that incorporate EBM components. Section 66600, the Declaration of Public Interest, states that, "…the bay is a single body of water that can be used for many purposes, from conservation to planned development; and that the Bay operates as a delicate physical mechanism in which changes that affect one part of the Bay may also affect all other parts." Section 66603 suggests it is understood that BCDC "treat[…] the entire Bay as a unit." Section 66605 concerning fill in the Bay essentially states that fill should not harm the ecosystem: "…the nature, location and extent of any fill should be such that it will minimize harmful effects to the [B]ay [A]rea, such as… water quality, fertility of marshes or fish or wildlife resources, or other conditions impacting the environment."[94]

In addition, several other areas of the McAteer-Petris Act include EBM language, including calls for the use of adaptive management in the White Slough Protection and Development section, a mandate for collaborative partnerships in its Dredging and San Francisco Bay Area Water Trail sections, and a call for a strong foundation of science in section 66632.4 under the Powers and Duties of the Commission. See Appendix A for the full list of specific EBM language contained within the McAteer-Petris Act.

The San Francisco Bay Plan (Bay Plan), as amended 1969, is composed of two parts: the policies to guide the management of current and future uses of the Bay and shoreline (including the findings), and the maps where specific policies and suggestions are applied to geographic areas of the Bay and shoreline.[95] The staff and Commission use the Bay Plan to guide

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[93] For more information and to see the entire McAteer Petris Act (1965), as amended, see http://www.bcdc.ca.gov/laws_plans/laws/mcateer_petris.shtml

[94] As defined in section 21060.5 of the Public Resources Code. Interestingly, this includes "other conditions" such as noise pollution, air quality impacts, and traffic issues, etc., which basically are all required to be addressed under the CEQA.

[95] For more information and to see the entire San Francisco Bay Plan (1969) as amended, seehttp://www.bcdc.ca.gov/laws_plans/plans/sfbay_plan.shtml

permitting, planning and policy decisions. It is clear that the authors of the Bay Plan were thinking regionally. They realized that one of the primary benefits of an agency like BCDC was that it could manage the entire Bay as one – especially regulating fill and ensuring public access – whereas local governments were unlikely to have the resources or incentives to look beyond their individual jurisdictions. Indeed, the themes of the Bay as one unit "in which changes affecting one part may also affect other parts" replay in the Bay Plan in numerous sections, including the introductory Summary and Mitigation.

Other sections are noteworthy. Calls for the use of adaptive management are evident in the Tidal Marshes and Tidal Flats and Mitigation section of the Bay Plan. The Bay Plan also includes several phrases indicating the interconnectedness within systems (interactions among species or sectors) in the subtidal areas section where it speaks to the linkages between subtidal and other Bay habitats. Please see Appendix B for the full list of specific EBM language contained within the Bay Plan.

The call for special area plans (SAPs) in some sections of the Bay Plan could allow BCDC to move away from its permit-by-permit regulatory framework. SAPs are designed to be place-based in nature and to manage for multiple human uses and activities, such as coastal development and transportation. Future SAPs, however, would need to be used more comprehensively to include interconnections between the built environment and the natural environment, between land, sea, and air and between sectors. Other states, such as Rhode Island, actively engage in special area plans – known as special area management plans (SAMPs) – to regionally manage for a specific area and its human uses and activities.[96]

Other EBM connections are less clear, or nonexistent, in both guiding documents. The Bay Plan calls for the use of integrated watershed management to *reduce* soil erosion, but BCDC lacks the ability to ensure that ample sediment remain in suspension and freely flow down into the Bay to allow for adequate wetland transgression. This is an important management gap, limiting the ability of the agency to address the impacts of projected sea level rise. Additionally, several significant EBM components are absent from BCDC's guiding documents, undoubtedly because of their newness in the coastal management field. Absent in both documents is any mention or suggestion of the requirement to employ the use of EBM tools, although policies calling for a strong foundation of science could be used to incorporate these tools into policy and management decisions. Likewise, there is no mention or suggestion of marine spatial planning and/or comprehensive zoning or language concerning ocean observation.

In summary, both the McAteer-Petris Act the San Francisco Bay Plan lend themselves well to further implementation of certain ecosystem-based approaches to management and broader use of EBM. BCDC's recognition of the importance of collaborative partnerships and its ability to undertake such efforts are vitally important. Interagency efforts build trust, common language, and a shared understanding of circumstances and issues – all of which improves the ability to manage and protect natural resources.[97] BCDC's limited jurisdiction necessitates collaborative approaches to interact with other projects outside of its direct jurisdiction which may affect the health of the Bay and the safety of its inhabitants, both human and wildlife. This may be the most effective way to protect Bay resources without a more holistic jurisdiction, specific legal mandate, and increased staff and funding.

Despite BCDC's collaborative approach, it is still constrained to move toward EBM by its lack of additional enforceable policies regarding several EBM components. These guiding documents could be strengthened to provide a legal basis for the implementation of other EBM components, such as MSP and zoning, cumulative impact management, ocean observing, and integrated watershed management (which will be discussed in Chapter 5).

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[96] For more information, see http://seagrant.gso.uri.edu/oceansamp/index.html

[97] Point Reyes Bird Observatory, California Current Joint Venture: Building collaboration at the Regional Scale. Online at http://www.prbo.org/cms/231

Other specific documents that the agency uses for planning and regulatory guidance – including specific Special Area Plans and the Suisun March Preservation Act and Suisun Marsh Protection Plan – will not be discussed in specific detail in this report. These documents are, in general, examples of more specific place-based management efforts based upon location (e.g. Richardson Bay) and habitat type (e.g. Suisun Marsh) in contrast to those policies and findings of the Bay Plan based upon various sectors of human uses and activities.

Other Governance Considerations

Additionally, two overarching governance factors make it challenging for BCDC to evolve from its collaborative management approach.

Firstly, the Bay Area is heavily managed by various entities whose jurisdictions overlap and whose mandates vary among interests and responsibilities. These entities, like BCDC, have been built with explicitly upon specific sectors, such as endangered species, shipping, invasive species, water quality, and fisheries. However, ensuring the provision of ecosystem services benefits all sectors. Provisioning (e.g. seafood), cultural (e.g. windsurfing), regulating (e.g. wetland filtering), and supporting (e.g. nutrient cycling) services are critical to the health and well-being of the San Francisco Bay, its natural resources, surrounding watersheds, the region's economy, and thus the quality of life of the Bay's inhabitants.

BCDC has engaged significantly in numerous collaborative efforts around the Bay Area with much success and should continue to do so more comprehensively. An exemplar of regional collaboration with a more holistic mindset is the Joint Policy Committee. The JPC was originally established to better coordinate the management actions of Association of Bay Area Governments (ABAG), the Metropolitan Transportation Commission (MTC) and the Bay Area Air Quality Management District (BAAQMD) to create more livable communities in areas served by transit and to promote conservation of the region's significant resource lands. In 2009, BCDC joined the JPC as a voting member to assist in the regional response and adaptation planning and management of impending sea level rise and other climate change impacts.

To coordinate and unify collaborative efforts around the Bay Area, a public-private partnership could be founded and based upon a standardized and agreed upon suite of EBM guidelines. Participation in such an interagency and academic effort would create agreement, shared responsibilities, and ecosystem-based policy direction, beyond each institutions mandates and specific responsibilities. An agreed upon set of ecosystem-based guidelines could pave the way for further transitions toward broader EBM implementation, with specific mandates to engage in marine spatial planning, integrated watershed management, and cumulative impact assessment and management. Knowledgeable natural and social scientists should be engaged in crafting the content of the ecosystem-based guidelines, which could be general in nature, such as, "The provision of ecosystem services shall be assured for present and future generations and is the highest management priority for all agencies," or more specific such as, "All agencies shall move toward reducing the amount of discharge to the Bay's waters, with the goal of the entire Bay becoming a no-discharge zone by 2025."

The Puget Sound Partnership (PSP) is discussed here as a potential model for such a partnership in the Bay Area.[98] The PSP is a community effort of citizens, governments, tribes, scientists and businesses working together to restore and protect Puget Sound. Mandated by the Governor of Washington and the Legislature, the PSP is charged with creating an Action Agenda to prioritize cleanup and improvement projects, coordinate federal, state, local, tribal and private resources, and ensure that all entities are working cooperatively. In December 2008, the PSP completed its selection of provisional environmental indicators that can be used to track

[98] For more information on the Puget Sound Partnership, see http://www.psp.wa.gov

the health of the Puget Sound ecosystem for five ecosystem components: water quality and quantity, human health, habitat, species and food webs. In addition, the PSP Science Panel released their Biennial Science Work Plan 2009-2011, which details the PSP's approaches to adaptive management, integrated ecosystem assessments, ecosystem services and socioeconomic indicators.

Success of the PSP has been widespread. Through these efforts and others by the PSP, 13 local governments have added Low-Impact Development (LID) to development and stormwater codes, the Puget Sound Salmon Recovery Plan has been adopted by NOAA and guides a coordinated, ecosystem-wide restoration effort, and education, communication and outreach program (ECO Net) has been created. ECO Net draws on the combined experience and community-level knowledge of existing networks and efforts to increase public awareness and involvement and individual stewardship of Puget Sound.

Secondly, BCDC's limited jurisdictional authority does not allow for enforceable policies to be extended to more sustainable low-impact development practices within the Bay Area, or to require restoration efforts in the Bay's more remote watersheds. Since approximately 80% of marine pollution (debris and contaminants) originates on land, it is difficult to ensure the health and quality of the Bay without direct enforceable policies above and beyond the Bay's shoreline band. Concurrently, it has been shown that despite the EBM language, the Bay Plan was developed at a time when a species- or sector-based approach to environmental management seemed appropriate based on our limited understanding of natural resource management. Today, it is widely recognized that managing interconnections within and among ecosystems and the people that depend on them is an improvement upon managing individual species or sectors in isolation.

Despite its reliance on sound science and that policy decisions are based on the entirety of the Bay Plan rather than on individual sections, the Bay Plan essentially creates a foundation for management by sector through its sectional layout.[99] As it is now, the Bay Plan is dividedin large part by sector – transportation, shoreline structures, dredging, etc. – with little regard to where in the Bay those sectors are operating or to what other sectors they are interacting with.[100] Although maps are used to designate certain policies for certain areas and the Bay Plan is meant to be read and applied as one document, policies and findings would arguably be different if they were to be based on a particular geographic region, or ecoregion, for example.

One such solution could be a restructuring of the Bay Plan's organization, or a study to consider potential changes to its organizational structure. This would be an integral first step in incorporating additional ecosystem-based approaches to management into the planning and regulatory decisions of the staff and Commission, as well as helping the agency move toward broader implementation of EBM.

Ecoregions are designed to represent the ecological interconnectedness between the upland, intertidal and subtidal regions, and thus stretch from the upland watersheds to the depths of San Francisco Bay. These are based on a number of ecological variables including bathymetry, habitat-type, species composition, salinity, and watershed boundaries. Redesigning the Bay Plan to incorporate these "priority ecosystem zones" could provide for both enforceable and advisory policies within the ecoregions for areas that are both inside BCDC's jurisdiction and outside of it. This action would incorporate various EBM components and would better link land-use policy with the San Francisco Bay, create better connectivity between the Bay's habitats from the subtidal to the intertidal to the upland, and potentially allow climate change adaptation policies to be applied better to particular regions.

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[99] Sectors of the Bay Plan include Dredging, Water-Related Industry, Airports, Ports, Transportation, Recreation, and Commercial Fishing.

[100] Fortunately, the Bay Plan maps do draw connections between policies and geographic areas around the Bay, and some Bay Plan sections are based upon habitat-type, such as managed wetlands and tidal flats and tidal marshes.

CHAPTER 5

BCDC AND ECOSYSTEM-BASED APPROACHES TO MANAGEMENT FOR THE BAY AREA

The next subsections illustrate several major EBM efforts underway in various capacities in the Bay Area. These examples of existing efforts support the recommendations that EBM components be more fully encapsulated into BCDC's laws, policies, and practices for broader EBM implementation in the Bay Area.

Marine Spatial Planning and the San Pablo Bay Marine Spatial Planning Pilot Project

The concept of, and efforts to, implement comprehensive MSP – where the entirety of an ecosystem is planned, zoned, and managed – are gaining traction throughout the United States and other parts of the world.[101] As on land, ocean zoning reduces conflicts among various users by separating incompatible activities. To achieve conservation goals, a zoning plan would also stipulate what levels of use are allowed. Ecologically critical areas—nursery grounds for fisheries and riparian wetland buffers, for instance—would merit the strictest protection. Degraded or relatively less critical areas could be designated for industrial uses such as ports, wind farms, or oil extraction.[102]

Traditionally, sectoral zoning in the ocean has often been designated and demarcated with little consideration of critical places or habitats, resource distributions, or potential human conflicts.[103] Generally, these zones are termed *de facto* and are quite widespread throughout the ocean as they are in San Francisco Bay.[104] What makes ocean zoning different from and potentially more successful than current conservation efforts is that practitioners, such as BCDC, wanting to mitigate threats to a specific portion of the marine realm can cast a wider net – affecting change to stressors outside of the immediate area of concern.

To investigate this concept, the San Pablo Bay Marine Spatial Planning Pilot Project was developed as part of the Fellowship to demonstrate both the process and illustrate the results (zoning scenarios and human use guidelines) of comprehensive ecosystem-based zoning in a portion of San Francisco Bay.[105] The results consist of alternative zoning scenarios and human use guidelines for San Pablo Bay (SPB). The first project objective was to identify the suite of current and potential future human uses of SPB and identify the current and potential future conflicts between and among these uses. The second project objective was to develop a range of comprehensive zoning schemes to manage these human uses that: (1) illustrated the current *de facto* zoning scheme; (2) minimized current and potential future conflicts among users; and (3) addressed the cumulative impacts of those uses through the utilization of a newly released human use impact assessment framework. An Advisory Stakeholder Committee (ASC) was assembled with members representing agency, government, and non-profit interests from around SPB.

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[101] Notable examples exist from Belgium, Germany, China, Australia, as well as Rhode Island, Massachusetts, and California.
[102] Agardi, *supra* note 35.
[103] Oran R. Young et al. 2007. Solving Ocean *Governance: Place-Based Management of Marine Ecosystems*. Environment, Vol. 49, No. 4, pp. 20-32.
[104] For example, ship channels, disposal areas, mineral leases, aquaculture sites, MPAs, etc.
[105] For a much more detailed examination of the San Pablo Bay Marine Spatial Planning Pilot Project, see the full report available at BCDC.

Considerable research was conducted and databases were created depicting the Bay's subtidal habitats and submerged property ownership.[106] This information, and other data, was used to map San Pablo Bay's known human uses, habitat types, submerged lands ownership, and *de facto* zones using a geographic information system (GIS).

Figure 3 depicts San Pablo Bay's *de facto* zones. The information contained within this map includes jurisdictional lines, anchorage areas, wildlife refuge boundaries, dredge disposal sites and shipping lanes and location of eelgrass beds. As the map indicates, these zones overlap in many areas and create a complicated, haphazard, and often incompatible display of human uses and activities.

Concerns for wildlife, fisheries, habitat types, recreational uses, security, navigation, transportation, and commerce were addressed in the placement of zone-type location and size based on: (1) the current zoning schema of San Pablo Bay; (2) the involvement, advice, and feedback from the ASC; and (3) independent research on zoning scenarios from around the world. Nine zone types were identified from this process. Existing eelgrass beds are color-coded pink to indicate the creation of the Preservation Zone. Federal shipping lanes, dredged channels, and ferry routes (current and proposed) are incorporated into the Commerce Zone (Yellow). Regional, state, and national wildlife areas are grouped together in the Refuge Zone (Green), which contain existing protections for rare (sandy beaches) and threatened species (clapper rail) habitat. The military danger zones and various prohibited access areas are combined to form the Security Zone (Red). Newly created zones in San Pablo Bay include the General Use Zone (Orange), Fisheries Zone (Light Blue) and the Buffer Zone (Dark Blue). In addition, two additional zones are proposed and illustrated: (1) the New Preservation Zone (Pink and Green thatch) is comprised of areas in San Pablo Bay where experts have concluded the potential exists for eelgrass restoration based on bathymetry, habitat, salinity, and light attenuation, and (2) the New Refuge Zone (Blue and Green thatch) is made up of two areas where additions to the Refuge Zone make spatial and ecosystem sense by reducing fragmentation of habitat type and coordinating management.

Using these zone-types, three scenarios were created which provide for a 'high-use,' 'mixed-use,' and 'low-use' alternative to the current *de facto* 'no alternative' scenario, depending on the amount of space allotted to each zone type. This range of scenarios – from higher freedom of use to higher conservation – is designed to create a forum for further discussion and stakeholder involvement. It was concluded that potential modifications to these alternative scenarios should be based upon ecological goals for each zone, the assurance of ecosystem services, and the management of cumulative impacts.

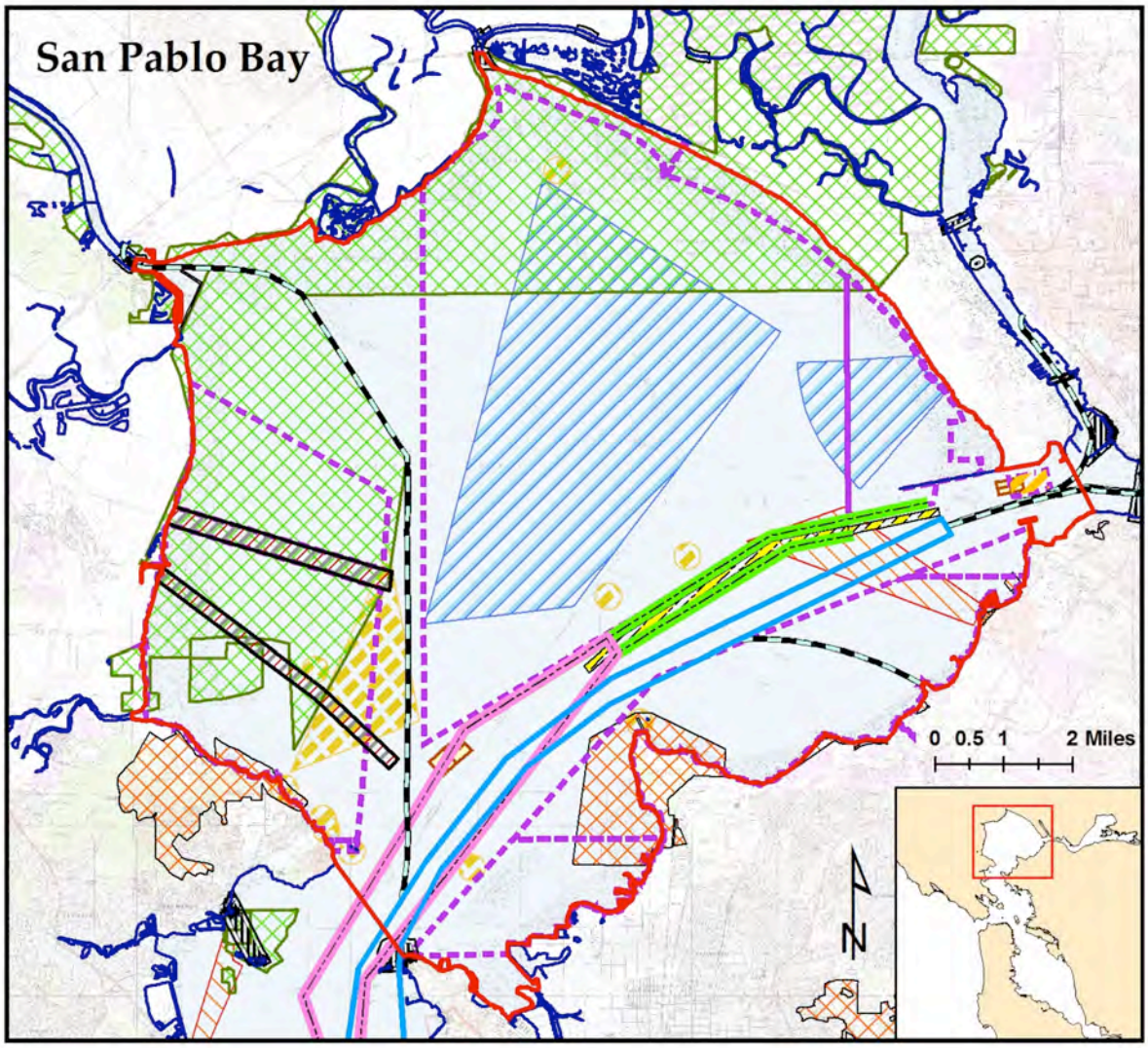
Associated human use guidelines were created and color-correspond to each zone-type. The guidelines indicate and explain the proposed allowed, permitted, and prohibited (APP) uses and are based upon the Bay's human uses, habitat types, and similar guidelines developed by the Great Barrier Reef National Marine Park. In addition, a Cumulative Impact Assessment (CIA) exercise, based upon the aforementioned framework developed by the National Center for Ecological Assessment and Synthesis (NCEAS), was conducted which informed the APP uses within each zone.

Figures 4-6 depicts the spatial results of the pilot project and serves as examples of potential alternative zoning scenarios for San Pablo Bay.

[106] This data was taken from a larger database and mapping effort covering the entire San Francisco Bay for subtidal habitats and submerged lands ownership.

San Francisco Bay
Conservation and Development Commission

Current De Facto Zoning Scenario 'No Alternative'



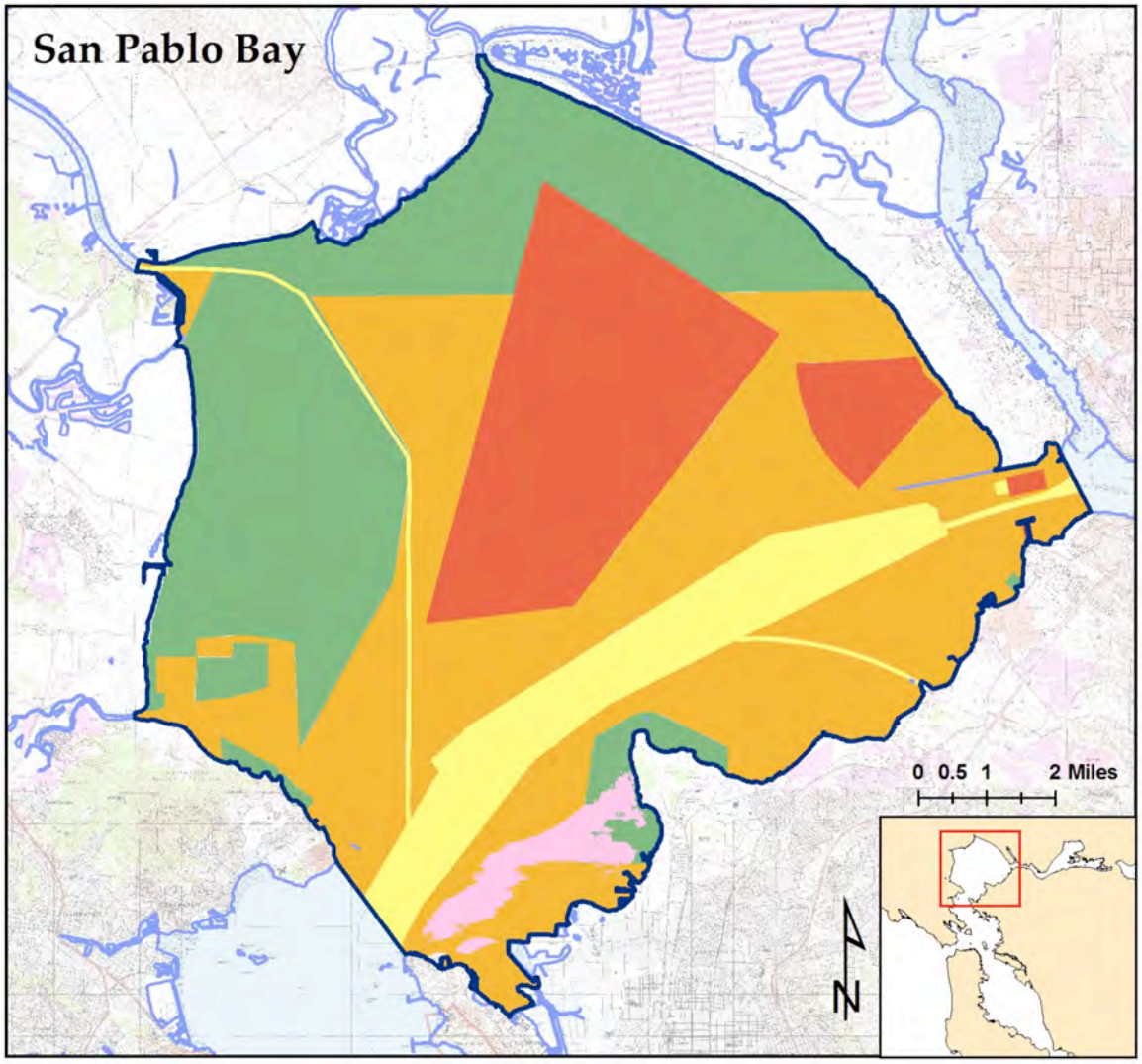
- Plan Boundary
- Proposed Ferry Track Lines (NOAA, Harbor Commission)
- Proposed Ferry Routes (WETA, BCDC)
- Pinole Shoal Channel (NOAA ENC)
- San Pablo Straight Channel (NOAA ENC)
- Security Zone (Coast Guard)
- CableArea (NOAA ENC)
- Pipeline Area (NOAA ENC)
- General Anchorage Area (NOAA ENC)
- Pinole Shoal Dredged Channel (NOAA ENC)
- Regional Park (NOAA ESI)
- Wildlife Areas (NOAA ESI)
- Military Danger Zone (NOAA ENC)
- Recreational/Subsistence Fishing (Fish-N-Map, BCDC)
- Wind/Kite Surfing (BCDC)
- Dredge Disposal Sites (ACOE)

Sources: NOAA Electronic Navigation Charts, NOAA Environmental Sensitivity Index, San Francisco Bay Conservation and Development Commission, U.S. Army Corps of Engineers, U.S. Coast Guard, Water,Transportation and Emergency Association (WETA), SF Harbor Commission, Fish-N-Map Co., Digital Raster Graphic 2005 Imagery Disclaimer: These maps are for informational purposes only. Users, by their use, agree to hold harmless and blameless the State of California and its representatives and its agents for any liability associated with its use in any form.

Dan Robinson, NOAA-CSC (2009)

San Francisco Bay
Conservation and Development Commission

Alternative Zoning Scenario 1 'High-Use'



Plan Boundary
Security Zone
Refuge Zone
Commerce Zone
Preservation Zone
General Use Zone

Sources: Zones based on current zoning scenario; NOAA Electronic Navigation Charts, NOAA Environmental Sensitivity Index, San Francisco Bay Conservation and Development Commission, Merkel and Associates, U.S. Army Corps of Engineers, U.S. Coast Guard, Water,Transportation and Emergency Association (WETA), SF Harbor Commission, Fish-N-Map Co., SF Estuary Institute. Digital Raster Graphic 2005.

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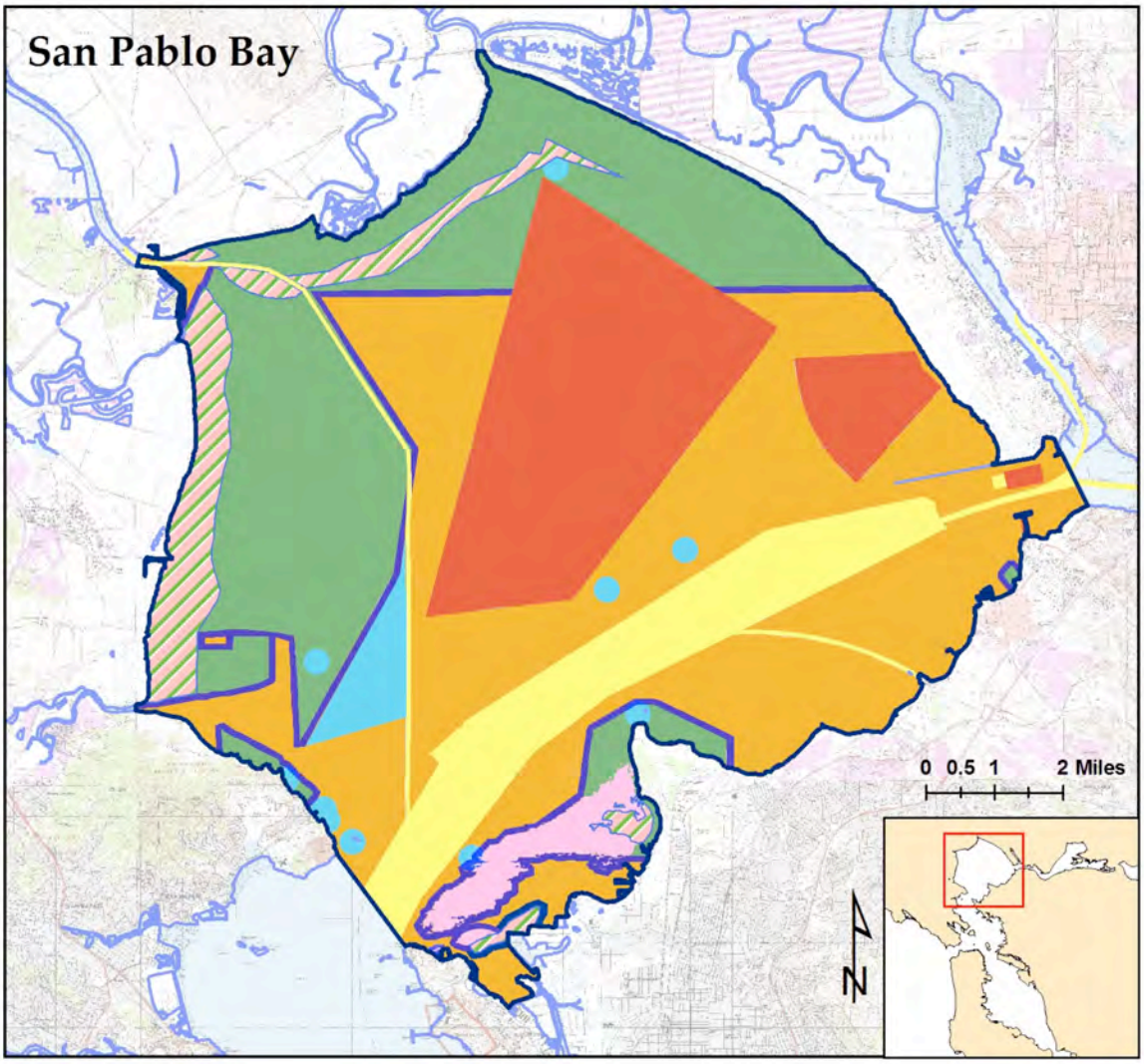
San Francisco Bay
Conservation and Development Commission

Alternative Zoning Scenario 2 'Mixed-Use'



Plan Boundary	New Preservation Zone	Fisheries Zone
Commerce Zone	Preservation Zone	Refuge Zone
Security Zone	Buffer Zone	General Use Zone

Sources: Zones based on current zoning scenario; NOAA Electronic Navigation Charts, NOAA Environmental Sensitivity Index, San Francisco Bay Conservation and Development Commission, Merkel and Associates, U.S. Army Corps of Engineers, U.S. Coast Guard, Water,Transportation and Emergency Association (WETA), SF Harbor Commission, Fish-N-Map Co., SF Estuary Institute. Digital Raster Graphic 2005.

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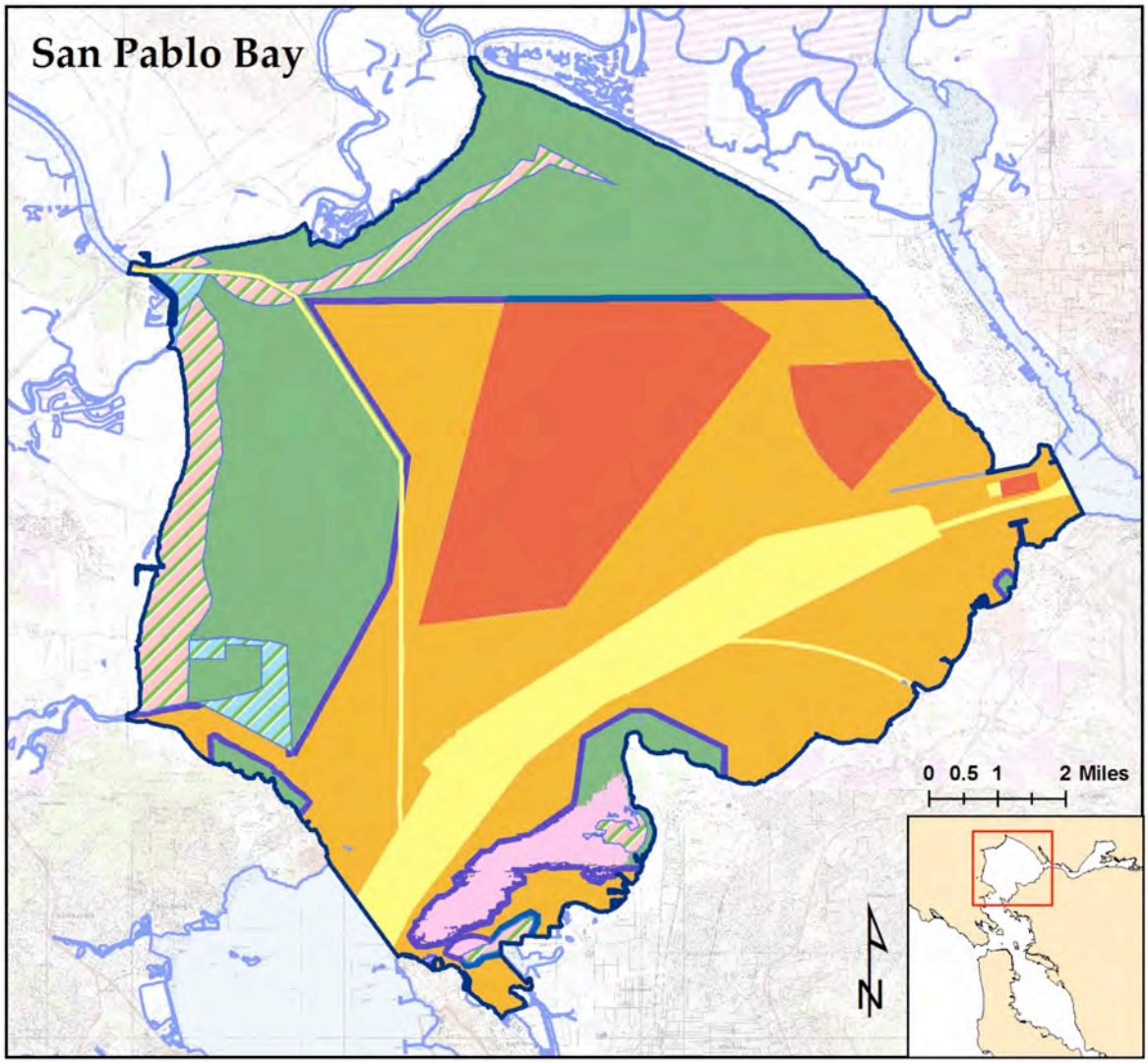
San Francisco Bay
Conservation and Development Commission

Alternative Zoning Scenario 3 'Low-Use'



Plan Boundary	New Preservation Zone	Security Zone
Commerce Zone	Preservation Zone	Buffer Zone
New Refuge Zone	Refuge Zone	General Use Zone

Sources: Zones based on current zoning scenario; NOAA Electronic Navigation Charts, NOAA Environmental Sensitivity Index, San Francisco Bay Conservation and Development Commission, Merkel and Associates, U.S. Army Corps of Engineers, U.S. Coast Guard, Water,Transportation and Emergency Association (WETA), SF Harbor Commission, Fish-N-Map Co., SF Estuary Institute. Digital Raster Graphic 2005.

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Analysis and Benefits. While the pilot project was only designed for planning purposes – and thus stopped short of implementation and additional steps in the MSP process – these scenarios give agencies, policy makers and coastal managers a potentially new vision for improved marine management in the San Pablo Bay.

Several other benefits of such a marine spatial planning effort are evident. A cumulative impact analysis framework was adapted from a more detailed framework developed by researchers at the National Center for Ecological Analysis and Synthesis (NCEAS) at the University of California Santa Barbara. This type of analysis can quantify the impacts of various sectors of human use and activities on particular ecosystems to better manage for cumulative impacts. Employing the use of impact-score caps for each zone type through the use of a cumulative impact framework is one way to go about this. The Refuge Zone and Preservation Zone, for instance, would have a lower tolerance (capped at a certain number) for cumulative impacts while the Commerce Zone would allow for a higher tolerance of cumulative impacts. Another way to amend the zones is through the use of goal setting for each zone type. Ecological goals, such as a reduction of cumulative impacts, or quantitative goals, such as a 25% area reduction in the Security Zone by 2020, could be used as a stress indicator to assess and better manage each particular zone type and cumulatively San Pablo Bay. This indicates where potential mitigation may be necessary and where zones may need to be amended – in size and location – to reduce conflicts or eliminate incompatible human uses and activities.

Comparing the different zone types can lead to a better understanding of the impacts occurring within them. This more in-depth analysis could lead a larger stakeholder group to suggest a particular zone be reduced or enlarged in size. Reducing the General Use Zone, for example, by increasing the Refuge Zone, reduces the size of the area in which high impact uses are allowed to occur. This reduction in size may reduce the amount of high impact activities occurring in San Pablo Bay, which would arguably benefit the ecosystem and those who depend upon it. Conversely, increasing the size of the General Use Zone, for example, at the expense of the Refuge Zone, increases the area where both higher and lower impact human uses can occur, potentially increasing the amount of those uses and reducing the overall health of the ecosystem.

The three color-coded zoning scenarios could be adapted to create "submerged lands zones" with each zone allowing and prohibiting certain uses and impacts. BCDC, the California Coastal Conservancy, the Association of Bay Area Governments, Save the Bay, the U.S. Army Corps of Engineers, and others, could use this information for planning purposes. For example, watershed management groups could use the zoning scenarios as a starting point to better match the zoning scenarios currently in place on land. Symbioses between land and water zones are in place in various areas of the Bay (e.g. the industrial area in Richmond and the General Use Zone in the southeast corner of San Pablo Bay, or the Hamilton Restoration Site in Novato and the Refuge Zone in the north and west portions of San Pablo Bay), but closer inspection of land- and water-based zones could add to benefits that come from the SPBMSP.

Climate change adaptation and mitigation efforts happening all around San Francisco Bay could also potentially benefit from the products and results of the SPBMSP. The zoning scenarios could be used to plan for future zoning of sea level rise-induced inundation areas. Inundation mapping undertaken by BCDC shows that a large portion of the land north of San Pablo Bay will be inundated within 100 years. While these areas are mostly within the San Pablo Bay National Wildlife Refuge, some are not. Marine spatial planning for these land-based areas that will become water-based areas without shoreline protection, could provide substantial resource and public safety benefits. The zoning scenarios could be expanded to show these inundated areas 25, 50, and 100 years from now. Some inundated areas may be remote enough to be incorporated into a refuge or preservation zone, while some may be close to important infrastructure and, therefore, may warrant incorporation into a general use zone.

Beyond the benefits of MSP and comprehensive zoning illustrated above, researching, acquiring the data, and mapping the human use and activities, habitats, and *de facto* zones for the entirety of San Francisco Bay would assist in understanding the key ecosystem services in the region and the spatial distribution of these services. This is critical as BCDC's evolution to a holistic, dynamic, partnership-driven, and adaptive management approach continues.

Implementation Challenges. The SPBMSP will require several additional steps prior to implementation. In general, the SPBMSP project was designed to serve as a springboard from which to explore issues that may hinder implementation of MSP in greater San Francisco Bay.

Obstacles that would require a larger stakeholder process for implementation in San Pablo Bay or elsewhere, include: (1) identifying and securing a stable funding source; (2) overcoming a general psychological resistance of individuals to curtail the "freedom of the common seas" through zoning; (3) demonstrating that the benefits of MSP outweigh the costs; (4) involving and engaging governments at all levels; and (5) engaging the public, private and nonprofit submerged lands owners. In addition, two other critical issues would need to be addressed: questions of authority, and the critical link between water and land-use planning and policy.

Perhaps the overarching question in any MSP process is who shall have the authority to manage such an effort and who will oversee the resulting plan. Numerous agencies, governments, and organizations exist in the San Pablo Bay Area, and no one entity has control over all human uses and activities. Answering the question of authority requires regional discussions among representatives from these stakeholder groups, and the public. These discussions may involve creating a wholly new authority to lead and oversee the MSP effort – an entity with governance regime that promotes ecosystem health and reduces user conflicts. Having one entity with the authority to lead such an effort and implement a marine spatial plan could help achieve more holistic management of the Bay.[107]

Another option is to have MSP efforts led and implemented by multiple agencies. This approach potentially sacrifices sufficient integration of ecosystem values in the planning process. For example, one agency could make decisions that undermine the overarching objectives for the MSP. A benefit of this approach is that it enhances the potential for incorporating existing agency expertise. This option is also more likely to be politically viable because the historic jurisdictional boundaries of existing agencies are maintained.[108]

A third option (which may be a precursor to either of the other two options) is to promote a finalized zoning scheme in absence of a legal mandate. This option would allow the zones to be tried and tested by stakeholders, agency representatives, and marine users of all kinds on a more informal basis. Users would be given a full packet of information on the different zones and zoning scenarios along with guidelines and GPS coordinates of each zone. These packets could be given out at various ports, harbors, and marinas, Bay Trail access points, and fishing piers throughout San Francisco Bay. Packets could also be made available at coastal management agencies, non-profit organizations, and local municipalities. The benefits and challenges of this option largely surround enforceability. While the informal nature of this approach lends itself well to wide investigation and trial, the lack of a legal mandate or authority for the zoning scenario deprives it of enforceability and could compromise its relative importance in the minds of the public.

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[107] Sivas, Deborah and Margaret Caldwell. 2008. *A New Vision for California Ocean Governance: Comprehensive Ecosystem-Based Marine Zoning*. Stanford Environmental Law Journal. Vol 27.
[108] *Id.* at 100. For a more lengthy description of power of authority options, including 2 other options involving Ecosystem Principles.

Integrated Watershed Management

San Francisco Bay is supplied with inflowing freshwater and sediments from local watersheds which are vitally important components of a healthy Bay ecosystem.[109] Improving the health and vitality of watersheds is increasingly seen as one of the best ways to ensure the health and vitality of their drainage areas, such as the San Francisco Bay. Concurrently, to ensure adequate wetland transgression along the Bay's, sufficient amounts of clean sediment will need to flow into the Bay edges to keep pace with sea level rise.

There are many examples of IWM programs and plans in the Bay Area that BCDC should continue to engage with and support, and collaborate more comprehensively with by combining these efforts with a marine spatial planning program to more holistically manage a the Bay from land to sea as a single unit. This is often termed "land-sea planning" overseas and is gaining wider support in the United States.

The Critical Coastal Areas (CCA) program aims to track and minimize contaminants and development pressures from the upper limits of a watershed to its drainage point in San Francisco Bay. The Sonoma Creek CCA is attempting to create a management plan for an area north of San Pablo Bay comprised of residential users, agricultural farms, urban areas, and numerous vineyards. A joint effort between the CCA and the SPBMSP project would create a more comprehensive vision of San Pablo Bay for improved decision-making and management because it would involve similar stakeholders who would be familiar with the area, it could better synthesize land-uses with similar zone types in the water, and it could better integrate sea level rise planning into a local government's shoreline planning decisions.

The Bay Area Integrated Regional Water Management Plan (IRWMP) is intended to provide a blueprint for caring for our Bay watersheds while meeting our region's clean water and flood protection needs[110] and is another avenue to engage more comprehensively in land-sea planning. As a model for collaboration, the IRWMP has succeeded in effectively coordinating different Bay Area agencies and organizations that pursue a variety of different water resource management mandates – restoring watershed habitats and natural hydrologic functions, taking advantage of streams as urban and suburban amenities, balancing the water needs of sensitive habitats with customer water demands, and ensuring that natural resources and habitats are shielded from potential adverse impacts associated with land and water management – to ensure that everyone is working together to ensure common Bay Area interests.[111] These interests include protecting the Bay-Delta watershed, managing impacts from an increasing population, addressing aging infrastructure needs, maintaining a vital economy, protecting health, safety and property, and increasing efficiencies and value added through coordination and collaboration.[112]

The importance of staff engaging more comprehensively with management of the Sacramento-San Joaquin River Delta is critical as the Delta is perhaps the single most important watershed in the western United States and its drainage into the San Francisco Bay. As such, it has been the epicenter of numerous water battles throughout the years and the scene of an ongoing management effort among state and federal entities through the CalFed Bay-Delta Authority.[113] Any increase to the amount of fresh water being diverted from the Bay to meet the demands of agriculture and California's growing population necessarily results in less water

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[109] J.N. Collins et al. 2004. *Synthesis of Scientific Knowledge for maintaining and improving functioning of the South Bay Ecosystem and Restoring Tidal Salt Marsh and Associated Habitats over the Next 50 Years at Pond and Pond-Complex Scales.* SFEI, Draft Final Report No. 308

[110] See the Bay Area Integrated Regional Water Management Plan (IRWMP). 2006. Retrieved from http://bairwmp.org/

[111] *Id.*

[112] *Id.*

[113] The CalFed Bay-Delta Program is a collaborative effort among 25 state and federal agencies to improve California's water supply and the ecological health of the San Francisco Bay/Sacramento-San Joaquin River Delta. See more at http://calwater.ca.gov/index.aspx

available for the Bay. In terms of climate change, changes in pH, salinity and temperature could endanger many species, as well as certain species of submerged aquatic vegetation, that rely on the delicate mixture of fresh and salt water that exists in the Bay estuary.

Successful efforts to engage in land-to-sea planning, including those linkages and processes between the subtidal, intertidal and upland environments, require current and accurate data such as submerged lands habitat-type information, topographic and bathymetric data, and sediment flow/change models. Continuing to engag in active partnership with watershed management efforts around the Bay Area, especially within the Sacramento-San Joaquin River Delta, will ensure that BCDC is kept informed of necessary data gaps and needs, contaminant issues, land-use decisions, species migration patterns, restoration efforts and others, which are all critical to ensuring the conservation and development of the Bay and its shoreline. The Regional Monitoring Program for Water Quality in the Bay has tremendously increased the amount of scientific knowledge concerning contaminant levels and pollutant distributions in the Bay, and is a valuable resource for BCDC. This effort has advanced scientific understanding of the Bay and its watersheds and has aided decision-makers throughout the Bay Area.[114]

Cumulative Impact Assessment and Management

Another component underneath the EBM umbrella that could greatly increase BCDC's collaborative management approach to move toward broader implementation of EBM is cumulative impact assessment and management.

Most regulatory decisions by BCDC are undertaken on a permit-by-permit basis, making it hard to address cumulative impacts on the Bay's ecosystem. This type of approach makes it almost impossible to consider, account for, and manage the cumulative impacts of the range of human activities when making individual policy or management decisions. SAPs enable staff to take a place-based approach to certain management areas, yet are infrequently used in a comprehensive manner (e.g. linking subtidal to intertidal to upland) or arguably often enough (4 in 45 years).

Fortunately, researchers from the University of California Santa Barbara's National Center for Ecological Assessment and Synthesis (NCEAS) developed the Global Map of Human Impacts on Marine Ecosystems.[115] This cumulative impact map was created through an analysis of numerous different human stressors (threats to the marine environment), such as artisanal fishing, sea temperature increase due to climate change, invasive species, and nutrient runoff.[116] The cumulative impact data can be downsized to any geographic area and applied to assist decision-makers involved in any project.

Using the cumulative impact data, the Bay Area's stressors could be quantifiably scaled from high impact to low impact depending on the degree to which they affect five vulnerability attributes: (1) the spatial scale; (2) the functional impact (species to entire community); (3) the frequency of the activity; (4) the resistance of the ecosystem to the activity; and (5) the recovery time of the ecosystem to the activity. Stressors that rank high in several or all of these five measures emerge as dominant stressors and those that rank high in few or none are weak stressors.[117] Habitat destruction of any kind, for example, ranks extremely high, because it completely removes foundation species that support entire biological communities. Other

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[114] For more information on the Regional Monitoring Program see http://www.sfei.org/rmp/

[115] A study by Ben Halpern and others (Halpern et al. *Evaluating and Ranking the Vulnerability of Global Marine Ecosystems to Anthropogenic Threats*, 2007, Conservation Biology, Vol. 21, No. 5, 1301-1315) found that out of 38 distinct anthropogenic threats to marine ecosystems only one of the greatest threats (i.e. highest impact scores, of which there were 7) was ocean based: demersal destructive fishing – e.g. trawling, including bycatch. Clearly, land-based stressors are significant.

[116] *Id.*

[117] See http://www.sciencemag.org/cgi/content/full/sci;319/5865/948/DC1 to download the supporting material for A Global Map of Human Impact on Marine Ecosystems.

stressors may be dominant or weak depending on the situation: for example, changes in sediment input due to damming rivers or over-development of agricultural lands have large consequences for salt marsh accretion rates, but probably much smaller effects on kelp forest and pelagic ecosystems.[118]

Recently, this assessment framework was employed on a regional level for the Northwest Hawaiian Island chain,[119] and the California Current large marine ecosystem.[120] The California study resulted in conclusions similar to other studies: coastal ecosystems near high human population densities are the most heavily impacted, and impacts from multiple threats are ubiquitous. Two interesting results of this study were that climate change (sea surface temperature increases, ultraviolet radiation, and ocean acidification) was the top threat, and that the results of this study spatially correlated with the aforementioned global study, indicating that the global model could provide guidance to areas without local data or resources to conduct similar regional-scale analyses.[121]

It is crucial to the marine spatial planning (MSP) process to understand the holistic landscape of both high impact and low impact stressors, and to use a tool such as this, to quantitatively gauge the impacts of a certain set of uses. This in turn allows for better spatial planning of different human uses with a variety of policy implications. For instance, managers could isolate the activities with high impact to areas where the impacts and conflicts are minimized (e.g. no dredging near eelgrass beds), while still allowing activities that cause low impact stresses to co-occur.[122]

Additionally, for BCDC, this methodology is ideal for regional-scale and other regulatory decisions. This framework could help marine spatial planning efforts within the Bay and help link efforts with those outside the Bay.[123] Concurrently, an assessment of the Bay Area's stressors at a local scale would benefit BCDC's planning and regulatory decision-making processes, as well as a host of interagency efforts BCDC is engaged in.

Ocean Observing Systems and Programs

In May 2009 a CeNCOOS pilot project was recently completed in San Francisco Bay to test the use of advanced moorings combined with undersea and wireless networking for displaying real-time environmental data online. Hosted by San Francisco State University's Romberg Tiburon Center in Tiburon, CA, several universities and state and federal agencies collaborated on this project. Current profilers in hydrodynamic moorings were used to observe currents throughout the water column and transmit data to shore via a US Coast Guard navigation buoy.[124] The long-term plan is to make such information available all the time, and use it to link the new Bay circulation model in development by UC Berkeley and Stanford. The model output will in turn be used to address community needs in the areas of maritime safety, water quality,

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[118] See Roman et al. 1997, *Accretion of a New England (USA) salt marsh in response to a inlet migration, storms and sea-level rise*. Estuarine Coastal and Shelf Science, Vol. 45, No. 6, 717-727; and Kearney 1991, *Island land loss and marsh vertical accretion rates evidence for historical sea-level rise changes in Chesapeake Bay*. Journal of Coastal Research, Vol. 7, No. 2, 403-415.
[119] Selkoe et al. 2009. *A Map of Human Impacts to a 'Pristine' Coral Reef Ecosystem: the Papahanaumokuakea Marine National Monument.* Coral Reefs. doi: 10.1007/s00338-009-0490-z.
[120] Halpern, California Current, *supra* note 40.
[121] *Id.*
[122] Halpern et al. 2008. *Managing for cumulative impacts in ecosystem-based management through ocean zoning*. Ocean and Coastal Management, Vol. 51, p 203-211.
[123] A New Vision, *supra* note 107.
[124] For more on CeNCOOS's San Francisco Bay initiative, see http://www.cencoos.org/sections/conditions/sfbayweb/sfbayweb.shtml

spill containment, and ecosystem health.[125] This latter need will require better biological assessments of species habits and patterns, and indeed, CeNCOOS has plans to integrate increased ocean monitoring of species, larval dispersal patterns, and associated climate change trends, and to provide this information to decision-makers and the general public.

In addition, the Physical Oceanographic Real Time System (PORTS) is designed to provide crucial information in real time to mariners, oil spill response teams, managers of coastal resources, and others about San Francisco Bay's water levels, currents, salinity, and winds. In partnership with the NOAA's National Ocean Service (NOS); the California Office of Oil Spill Preparedness and Response (OSPR), the U.S. Geological Survey, and the local community, the Marine Exchange of the San Francisco Bay operates PORTS as a service to those who must make operational decisions based on oceanographic and meteorological conditions in the Bay.[126] The number, type, and mix of instruments that collect this information are deployed at strategic locations in the Bay both to provide data at critical locations and to allow nowcasting and forecasting using a mathematical model of the Bay's oceanographic processes.[127]

Staying abreast of the latest climate change effects and managing for them will require the latest scientific information. Increased ocean observing will allow greater regional monitoring of climate change impacts. Being at the forefront of this kind of regional climate data will provide BCDC with the information it requires to lead adaptation and mitigation efforts in the Bay Area, and thus, impart a solid foundation in which to base sound planning and regulatory decisions.

EBM Tools

A wealth of EBM tools now exists to better inform policy-decisions and management of the Bay's natural resources. The use of the latest EBM tools would allow BCDC to incorporate valuable data into the decision-making process and aid in evaluating management alternatives, as a means to satisfy the need for a strong foundation of science to support the agency's policies and findings. Figure 6 depicts a schematic of how EBM tools can influence and assist decisions at multiple stages of a planning process.

BCDC could use these new tools and technologies for a wide variety of purposes, such as siting future restoration sites, identifying appropriate setbacks on new coastal developments to plan for sea level rise, and planning for marine protected areas within the Bay to protect important habitat. However, to allow for this, the tools must be accessible and easy to use. The hiring of a full or part-time staff member (or consultant) with the technical skills to use, assist, and teach these new EBM tools should be a priority. This individual would be able to assist staff on a variety of day-to-day projects, as well as aid the Planning Department in its efforts to manage for climate change. Beyond these internal solutions, outside experts could be brought in to assess the state of the Bay on a 5 or 10-year basis to inform decision-making.

NOAA's integrated ecosystem assessment (IEA) is once such avenue. An IEA offers a consistent view of the status of each ecosystem examined and the resources needed for each management sector to understand the activities and impacts of others. In turn, it is likely that management of coastal and marine ecosystems will improve through integration of physical, biological, and social information.[128]

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[125] *Id.*

[126] The National Ocean Service (NOS) is responsible for providing real-time oceanographic data and other navigation products to promote safe and efficient navigation within U.S. waters. See http://sfports.wr.usgs.gov/SFPORTS/object.shtml

[127] *Id.*

[128] For more information on Integrated Ecosystem Assessments see http://coastalscience.noaa.gov/about/iea.html

One approach that is gaining wide support in the EBM community is a framework for assessing tradeoffs among ecosystem services developed by members of the Science Advisory Committee of the California Current Ecosystem-Based Management. Ecosystem tradeoff analysis builds upon economic decision theory and provides a means for visualizing and analyzing the potential tradeoffs among services. This approach provides a means for using science to evaluate alternative management options allowing us to make incremental progress towards EBM given current management, policy and legal constraints. The results would be useful to more comprehensive, large-scale EBM implementation in the future. Furthermore, this approach provides a means for demonstrating the added value of using an EBM approach or conversely, the costs of not taking into account important interactions among sectors, such as dredging and eelgrass restoration.[129]

EBM Tools Schematic

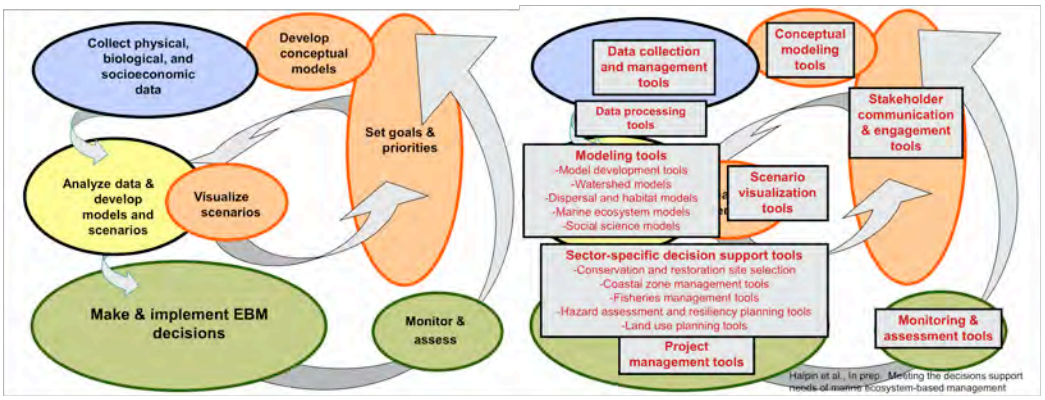

Figure 7. Opportunities for EBM Tools. Source: Halpin, et al. in prep., downloaded at http://www.ebmtools.org/about_ebm_tools.html.

[129] Sarah Lester, C. Costello, B. Halpern, C White, J. Barth, S. Gaines (in preparation) Ecosystem service tradeoff analysis.

CHAPTER 6

NEXT STEPS: BCDC, ECOSYSTEM-BASED APPROACHES TO MANAGEMENT AND CLIMATE CHANGE

Incorporating these EBM components can lead BCDC toward more comprehensive application of EBM. As BCDC's collaborative management approach continues evolving to address new challenges, newer EBM elements, principles, and tools can not only benefit the conservation of the Bay Area's ecosystem services, but also assist BCDC's continued leadership in climate change adaptation policy and management.

Today, the greatest threat to the San Francisco Bay Area from climate change will be to existing communities, public infrastructure, wetlands and numerous aquatic organisms and plants. The present day biophysical and socioeconomic make-up of the Bay will be altered in known and unknown ways, and climate change impacts will affect certain areas of the country quite differently. San Francisco Bay will be impacted differently – biophysically, socially and economically – than other parts of the California coastline, where there are large areas void of development, human populations, and low-lying areas.

Regional differences are requiring regional management to take the lead on research, education, and adaptation strategies for local and county governments, and BCDC is leading this movement in the Bay Area. This collaborative management approach aims to prioritize the health and safety of humans, while at the same time managing to protect biodiversity and the provision of ecosystem services.

In response to sea level rise impacts and other climate change concerns, BCDC is amending the Bay Plan to address climate change vulnerability and adaptation strategies for Bay Area governments.[130] Ecosystem based approaches to management are well suited to aid efforts to manage for a climactically altered future. Climate change is a dynamic issue, regional in scope, and vastly interconnected to numerous human uses and activities. Its impacts and interactions of those impacts are rife with uncertainty in time and space, and this uncertainty requires close collaboration to address its predicted effects. Additionally, even the most conservative climate change scenarios will certainly bring about alterations to the biophysical and socioeconomic landscape. This *threat* of climate change may trigger the type of focusing event that citizens, elected officials, scientists, academics, managers, and others need to seriously plan for the sustained provision of ecosystem services, which is the end goal for all ecosystem-based approaches to management.

The specific ways that EBM components can assist BCDC with both the provision of ecosystem services and addressing climate change in the Bay Area have been mentioned throughout this report. To reiterate, a variety of EBM tools could be used to answer questions such as where native and invasive species will migrate in a warmer future, how upwelling zones may function with changes in sea temperature, where marine protected areas need to be situated in order to preserve biodiversity of species and habitats, or how much sediment is necessary to ensure wetland transgression as sea level rises. Adaptive management is an inherent EBM principle that will be vitally important to be incorporated into policy and management decisions to allow for uncertainty of science and for changes based on rapidly changing information. Ocean observation systems can track ocean meteorological and biological trends and could help ensure that the latest and best available science is being used in

[130] BCDC, Climate Change, *supra* note 14.

policy and adaptive management decisions at BCDC. A cumulative impact assessment framework could regionally assess a variety of climate change stressors such as sea surface temperature and ocean acidification and create the type of hard science required to form sound policies. Keeping a long-term vision, explicitly using planning and project horizons of 50, 100, or 200 years could create a strong foundation for limiting or prohibiting development in areas vulnerable to sea level rise.

Today, the San Francisco Bay ecosystem struggles under a variety of human use and ecological pressures. As the climate invariably changes, so do the threats and dangers that challenge its health. Managers, scientists, and planners must utilize emerging elements, underlying principles, and fresh innovative tools and technologies to address damaged ecosystems, adapting their approach to respond to a vital realization: solutions to current environmental problems must be holistic, place-based, partnership-driven, dynamic, and adaptive. By using ecosystem-based approaches to management, BCDC can continue to transition toward broader EBM implementation, which can provide integrated solutions to these challenging issues.

APPENDIX A

THE McATEER-PETRIS ACT

Legal Language Embodying EBM Elements, Principles, and Tools

Chapter	**Section**	**EBM Language** (emphasis added)	**EBM Principle(s)**
Acts of the 1985 Session of the Legislature	Amendments Chapter 951 (AB 1102)	Amended Section 66621 to add the San Francisco Bay Regional Water Quality Control Board to the agencies whose data and information the Commission *must take maximum use of in its review*…	Collaborative Partnerships
Acts of the 2000 Session of the Legislature	Chapter 498 (AB 954)	Amended Section 66632.4 to require the Commission to *consult with* the Department of Fish and Game and use the *best available scientific evidence* to determine whether public access is compatible with wildlife protection…	Collaborative partnerships and a Strong foundation of science
1 Findings and Declarations of Policy	66600	"…the bay is a *single body of water* that can be used for many purposes..."	Place-based management
1 Findings and Declarations of Policy	66600	"…the bay operates as a delicate physical mechanism in which *changes that affect one part of the bay may also affect all other parts."*	Interconnectedness among systems
1 Findings and Declarations of Policy	66601	"haphazard filling…threatens the bay itself and is therefore inimical to the welfare of both *present and future* residents of the area surrounding the bay."	Long-term planning
1 Findings and Declarations of Policy	66601	"…a governmental mechanism must exist for *evaluating individual projects as to their effect on the entire bay*…"	Place-Based Management
1 Findings and Declarations of Policy	66601	"…piecemeal filling of the bay…may *destroy* the…feeding and breeding grounds of fish and wildlife… *adversely affect the quality* of the bay waters and… the quality of air in the bay area… and would therefore be harmful to the needs of the *present and future* population of the bay region."	Ecosystem protection and Long-term planning
1 Findings and Declarations of Policy	66603	"The legislature further finds and declares that the San Francisco Bay Conservation and Development Commission, treating the *entire bay as a unit*…"	Place-based management

Chapter	Section	**EBM Language** (emphasis added)	**EBM Principle(s)**
1 Findings and Declarations of Policy	66605	"…the nature, location, and extent of fill should be such that it will *minimize harmful effects* to the bay area…or other conditions impacting the environment…"	Ecosystem protection
1 Findings and Declarations of Policy	66606.6	"…the commission has prepared a *comprehensive* and enforceable plan…"	Place-based management
3 San Francisco Bay Conservation and Development Commission	66631	"the commission shall *cooperate to the fullest extent possible* with the Association of Bay Area Governments; and shall… *coordinate* its planning with planning by local agencies…"	Collaborative partnerships
4 Powers and Duties of the Commission	66632.4	"When considering whether a project provides maximum feasible access… the Commission shall, after *consultation* with the Department of Fish and Game, and using the *best available scientific evidence*, determine whether the access is compatible with wildlife protection in the Bay"	Collaborative partnerships and Strong foundation of science
5 The San Francisco Bay Plan and Further Reports of the Commission	66663.1 (c)	"it is in the interest of the state to establish a broad range of environmentally sound and economically feasible disposal options in order to protect fish and wildlife resources and other beneficial uses of the bay and the ocean"	Ecosystem protection
5 The San Francisco Bay Plan and Further Reports of the Commission	66663.1 (d)	"it is in the interest of the state to… assure adequate *monitoring* of dredging and disposal activities"	Monitoring and Review
5.5 San Francisco Bay Dredging	66663.2	"The legislature further finds and declares that the USACE, EPA, SWRCB, RWQCB, and BCDC have agreed to participate in a *joint effort* known as the LTMS"	Collaborative partnerships
5.5 San Francisco Bay Dredging	66663.2 (b)	"*Participation* with the USGS to make a detailed study of the bay sediment processes…"	Collaborative partnerships

Chapter	Section	**EBM Language** (emphasis added)	**EBM Principle(s)**
6 White Slough Protection and Development	66677 (b)	"… in order to preserve the integrity and to assure the continued wildlife use of White Slough, there is a need assurance that state interests in the area of white slough, including water quality, waterflow, habitat protection and enhancement… will be *protected."*	Ecosystem Protection
6 White Slough Protection and Development	66680	"…if, after three years it does not appear that the created wetlands will be fully functioning within the five-year period, then the wetlands *shall be further improved*…"	Adaptive management
7 San Francisco Bay Area Water Trail	66691 (a)	"San Francisco is the central feature in an *interconnected* open-space system of watersheds, natural habitats, waterways…"	Interconnectedness among systems
7 San Francisco Bay Area Water Trail	66691 (d)	"The designation of a water trail… would advance the *regional* goals… of the commission…"	Place-based management
7 San Francisco Bay Area Water Trail	66694 (b)	"In developing the San Francisco Bay Area Water Trail, the commission, in collaboration with the SCC and ABAG, shall establish and coordinate a *collaborative partnership* with other interested persons, organizations, and agencies…"	Collaborative partnerships
Assembly Bill No. 2094	Chapter 442	"…the bill would authorize BCDC, in *coordination* with local governments, regional councils of governments, and other agencies and interested parties to *develop regional strategies*…"	Collaborative Partnerships and Place-based management

APPENDIX B

THE SAN FRANCISCO BAY PLAN

Legal Language Embodying EBM Elements, Principles, and Tools

Part	Section	EBM Language *(emphasis added)*	EBM Principle(s)
1 – Summary	Introduction	"the Bay is a *single body of water*, in which changes *affecting one part may also affect other parts*"	Place-based management and Interconnectedness among systems
1 – Summary	Introduction	"only on a *regional basis* can the Bay be protected and enhanced"	Place-based management
1 – Summary	Introduction	"Implementation of the Plan…will guarantee to *future generations* their rightful heritage from the present generation…"	Long-term planning
1 – Summary	Conclusion	"The Bay is a *single physical mechanism* in which actions *affecting one part may also affect other parts*."	Place-based management and Interconnectedness among systems
II – Objectives	Objective 1	"Protect the Bay as a great natural resource for the benefit of present and *future generations*"	Long-term Planning

III – The Bay as a Resource: Findings and Policies			
Findings			
Fish, Other Aquatic Organisms and Wildlife	**Finding**	**EBM Language** *(emphasis added)*	**EBM Principle(s)**
	d.	"Conservation and restoration of these habitat components is essential to insure for *future generations* the benefit of fish, other aquatic organisms and wildlife in the Bay"	Long-term planning
	e.	"*All parts* of San Francisco Bay are important for the perpetuation of fish, other aquatic organisms, and wildlife because any reduction of habitat reduces their numbers in some measure"	Place-based management and Interconnectedness among systems
Policies			
Fish, Other Aquatic Organisms and Wildlife	**Policy**	**EBM Language** *(emphasis added)*	**EBM Principle(s)**
	4 (a)	"*Consult* with the California Department of Fish and Game and the U.S. Department of Fish and Wildlife Service or the National Marine Fisheries Service whenever a proposed project may adversely affect an endangered or threatened plant, fish, other aquatic organism or wildlife species"	Collaborative partnerships

Findings			
Water Quality	**Finding**	**EBM Language** *(emphasis added)*	**EBM Principle(s)**
	i.	"The *protection* of the Bay ecosystem and human health from water pollution requires a *comprehensive* strategy…"	Ecosystem protection and Place-based management
Policies			
Water Quality	**Policy**	**EBM Language** *(emphasis added)*	**EBM Principle**
	5	"The Commission should *support* the efforts of federal, state and local agencies in developing nonpoint source pollution control programs"	Collaborative partnerships

Findings			
Tidal Marshes and Tidal Flats	**Finding**	**EBM Language** *(emphasis added)*	**EBM Principle(s)**
	a.	"Plants and animals require a variety of *habitats* to survive"	Ecosystem protection
	d.	"Wetlands also are important habitat for the Bay's aquatic and upland plant and animal populations, serve as a primary link in the *ecosystem's* food chain, ensure the continued diversity of plant and animal communities…"	Ecosystem protection
Policies			
Tidal Marshes and Tidal Flats	**Policy**	**EBM Language** *(emphasis added)*	**EBM Principle**
	5	"Any tidal restoration project should include clear and specific *long-term* and short-term biological and physical goals…"	Long-term planning
	5	"…and *success criteria and a monitoring program* to assess the sustainability of the project."	Monitoring and review
	5	"If success criteria are not met, appropriate *corrective measures* should be taken."	Adaptive management
	6	"Any habitat restoration project approved by the Commission should include a program fro the periodic *monitoring* of the site for non-native species…"	Monitoring and review
	7	"(the Commission should) when feasible, support the establishment of a regional effort for *Bay-wide* eradication of specific invasive species…"	Place-based management

Policies			
	Policy	**EBM Language** *(emphasis added)*	**EBM Principle(s)**
Fresh Water Inflow	3.	"The Bay Commission should *cooperate* with the State Board and others to ensure that adequate fresh water inflows to protect the Bay are made available."	Collaborative partnerships

Findings			
	Finding	**EBM Language** *(emphasis added)*	**EBM Principle(s)**
Subtidal Areas	a.	"The subtidal areas of the Bay…are *intricately tied* to tidal flats and tidal marshes and are also *linked* to diked former parts…such as salt ponds, managed wetlands, agricultural Baylands, and adjacent upland habitats"	Interconnectedness within systems and Place-based management
	c.	Tidal and fresh water flows influence *all parts of the Bay* and move salt, sediment, and other substances, such as plankton, throughout it.	Place-based management and Interconnectedness among systems
	g.	"the Bay is a dynamic *ecosystem* influenced by natural processes on tidal and seasonal scales…"	Place-based management
Policies			
	Policy	**EBM Language** *(emphasis added)*	**EBM Principle(s)**
Subtidal Areas	1.	"Any proposed filling or dredging project in a subtidal area should be thoroughly evaluated to determine the local and *Baywide* effects of the project…"	Place-based management
	4.	"Any subtidal restoration project should include clear and specific *long-term* and short-term biological and physical goals…"	Long-term planning
	4.	"…and success criteria and a *monitoring program* to assess the sustainability of the project"	Monitoring and Review

Part IV – Development of the Bay and Shoreline: Findings and Policies			
Findings			
	Finding	**EBM Language** *(emphasis added)*	**EBM Principle(s)**
Dredging	m.	"Insufficient information exists about the potential benefits and adverse impacts on which to base *Baywide* policies governing disposal in the Bay… either through an individual project or *cumulatively* with other projects"	Strong foundation of science, Place-based management and Cumulative impact assessment
	n.	"*Baywide* studies would help determine the need for, appropriate locations for, and potential effects of in-Bay disposal for eelgrass or other shallow water habitat enhancement or restoration"	Strong foundation of science and Place-based management
	q.	"The Long Term Management Strategy (LTMS) program, initiated in 1991 in *partnership* with the Commission…"	Collaborative partnerships
	w.	"(2) identify *long-term* trends in Bay sedimentation that relate to dredging needs and potential impacts to Bay resource, such as wetland and mudflats."	Long-term planning
Policies			
	Policy	**EBM Language** *(emphasis added)*	**EBM Principle(s)**
Dredging	1.	In making its decision regarding disposal allocation, the Commission should *confer* with the LTMS agencies and consider… *regional* economic impacts…"	Collaborative partnerships and Place-based management
	8.	"The Commission should encourage increased efforts by soil conservation districts and public works agencies in the 50,000 square mile *Bay tributary area* to continuously reduce soil erosion…"	Integrated watershed management
	11 (2).	"A project that uses dredged material… should be approved only if… the project includes an adequate *monitoring* and management plan and has been carefully planned, and the Commission has established *measurable performance objectives and controls*…"	Monitoring and review
	6.	"The habitat project would not, by itself or *cumulatively* with other projects, significantly decrease the overall amount of any particular habitat…"	Cumulative impact assessment

Policies			
Dredging	7 (a).	"After a reasonable period of *monitoring*... the project has not met its goals and measurable objectives…"	Monitoring and review
	7 (b)(1)(a).	"The *Baywide* need for in-Bay habitat creation, enhancement and restoration…"	Place-based management
	7 (b)(1)(b).	"The need to use dredged materials to improve Bay habitat, the appropriate characteristics of locations in the Bay… and the potential short term and *cumulative impacts* of such projects;"	Cumulative impact assessment

Policies			
Water Related Industry	**Policy**	**EBM Language** *(emphasis added)*	**EBM Principle(s)**
	6.	"The Commission, together with the relevant local governments, should cooperatively plan… Such planning should include regional, state and federal interests… as well as public and special interest groups."	Collaborative partnerships

Findings			
Airports	**Finding**	**EBM Language** *(emphasis added)*	**EBM Principle(s)**
	e.	"The aviation needs of the Bay Area are regional in extent, and effective planning…can only be done on a *comprehensive, regional* basis."	Place-based management

Policies			
Public Access	**Policy**	**EBM Language** *(emphasis added)*	**EBM Principle(s)**
	3.	"projects in such areas (natural areas) should be carefully evaluated *in consultation* with appropriate agencies…"	Collaborative partnerships
	4.	"Where appropriate, effects of public access on wildlife should be *monitored* over time…"	Monitoring and review

Policies			
Public Access	10.	"Federal, state, regional, and local jurisdictions, special districts, and the Commission should *cooperate* to provide appropriately sited, designed and managed public access."	Collaborative partnerships
	13.	"The Commission should continue to support and encourage expansion of *scientific information* on the effects of public access on wildlife…"	Strong foundation of science

Policies			
Salt Ponds	**Policy**	**EBM Language** *(emphasis added)*	**EBM Principle(s)**
	3.	Any project for the restoration, enhancement or conversion of salt ponds to subtidal or wetland habitat should include… *long term* and short term biological and physical goals… a *monitoring* program…"	Long term planning and Monitoring and review
	3 (h).	"… *monitoring* and management of mercury methylation and sediments with contaminants;"	Monitoring and review
	5.	"To determine where and how much water surface area should be retained and how much public access should be provided… a *comprehensive* planning process should be undertaken…"	Place-based management
	5.	"… *collaboration* among local, state and federal agencies, landowners, other private	Collaborative partnerships
	5 (a).	"the planning process should incorporate [A] baseline *scientific* assessment…"	Strong foundation of science
	5 (b).	"*protect* and enhance onsite and adjacent *habitat* and species *diversity*;"	Ecosystem protection

Policies			
Managed Wetlands	**Policy**	**EBM Language** *(emphasis added)*	**EBM Principle(s)**
	3.	Any project for the restoration, enhancement or conversion of managed wetlands to subtidal or wetland habitat should include… *long term* and short term biological and physical goals… a *monitoring* program…"	Monitoring and review
	3 (g).	"Water quality protection measures that may include *monitoring* for constituents of concern…"	Monitoring and review

Findings			
	Finding	**EBM Language** *(emphasis added)*	**EBM Principle(s)**
Mitigation	c.	"A compensatory mitigation program will increase the likelihood of mitigation success when the program includes… a *monitoring* plan… a *contingency plan* in the event of project failure…"	Monitoring and review and Adaptive management
	c.	"… and provisions for the *long-term* maintenance, management and protection of the mitigation site."	Long-term planning
	e.	"A broad *scientific approach* to compensatory mitigation involves the location and design of mitigation sites based on a *Bay-wide assessment* to compensate for the adverse impacts…while also contributing to the *long-term ecological functioning of the entire Bay system."*	Strong foundation of science, Place-based management, and long-term planning
	h.	"Among other benefits, mitigation banks provide the unique opportunity to address the *cumulative effects* of small fill projects that are too small to be mitigated individually."	Cumulative impact assessment
Policies			
	Policy	**EBM Language** *(emphasis added)*	**EBM Principle(s)**
Mitigation	2.	"Individual compensatory mitigation projects should be sited and designed within a *Bay-wide* ecological context… ensure a high likelihood of *long-term* ecological success, an support the improved health of the Bay *ecological system*."	Place-based management, long-term planning, and Ecosystem protection
	7 (c).	"the mitigation program should include…a *monitoring plan* designed to identify potential problems early and determine appropriate remedial actions."	Monitoring and review
	7 (d).	"…A *contingency plan* to ensure the success of the mitigation project, or provide means to ensure alternative appropriate measures are implemented…"	Adaptive management
	8.	"Mitigation programs should be *coordinated* with all affected local, state, and federal agencies having jurisdiction or mitigation expertise…"	Collaborative partnerships

REFERENCES AND WORK CITED

Agardi, Tundi. 2009. "A Separate Peace," in *10 Ways to Save the Oceans*. Conservation Magazine.

Battelle Memorial Institute. July 2008. *Draft Final Report: Conceptual Benefits of Protection, San Francisco Bay Subtidal Habitat Goals Project.* Submitted to NOAA, San Francisco, CA.

Baur, Donald, Tim Eichenberg, and Michael Sutton (editors). 2008. "Legal Authorities for Ecosystem Based Management in U.S. Coastal and Ocean Areas," in *Ocean and Coastal Law and Policy*. American Bar Association , 1st Edition.

Bay Area Integrated Regional Water Management Plan (IRWMP). 2006. Retrieved from http://bairwmp.org on March 19, 2009.

Buck, Eugene H. 1993. *CRS Report for Congress: Marine Ecosystem Management*. Congressional Research Service.

California Current Ecosystem-Based Management Initiative (CCEBM). Retrieved from http://ims.ucsc.edu/CCEBM/public_detailspage.html on May 1, 2009.

Carr, Mark (UCSC) and Charle Wahle (MLPA). April 10, 2009. Presentation at Stanford Law School's Climate Change Conference.

CCEBM. "Advancing the Science for Ecosystem Based Management on the U.S. West Coast." 2-day Workshop, January 30-31 2008, Santa Cruz, CA.

California Environmental Quality Act (CEQA). 1970. Retrieved from http://ceres.ca.gov/ceqa/ on May 1, 2009.

California Ocean Protection Act (COPA). 2004. Retrieved from http://www.opc.ca.gov/council-documents/ on January 20, 2009.

Cayan, Dan, M. Tyree, M. Dettinger, H. Hidalgo, T. Das, E. Maurer, P. Bromirski, N. Graham, and R. Flick. 2008. *Climate Change Projections of Sea Level Extremes Along the California Coast.* Climate Change. 87 (Supplement 1): S37-S73. doi: 10.1007/s10584-007-9376-7.

Central and Northern California Ocean Observing System (CeNCOOS). Retrieved from http://www.cencoos.org/sections/about/about.shtml; http://www.cencoos.org/sections/conditions/sfbayweb/sfbayweb.shtml; http://www.cencoos.org/sections/news/sea_level.shtml on February 27, 2009

Collins, J.N., et al. 2004. *Synthesis of Scientific Knowledge for maintaining and improving functioning of the South Bay Ecosystem and Restoring Tidal Salt Marsh and Associated Habitats over the Next 50 Years at Pond and Pond-Complex Scales.* SFEI, Draft Final Report No. 308.

Communication Partnership for Science and the Sea (COMPASS). Retrieved from http://www.compassonline.org/ on June 29, 2009.

Clean Water Act. Retrieved from http://www.epa.gov/water/laws.html on June 15, 2009.

Dean, Cornelia. May 18, 2009. "As Alaska Glaciers Melt: It's Land That's Rising." The New York Times.

Department for Environment, Food, and Rural Affairs (DEFRA). 2007. *A Sea Change: a Marine Bill White Paper*. Marine Legislation Division. London, 176 p.

Department of the Interior. Retrieved from http://www.doi.gov/initiatives/AdaptiveManagement on May 1, 2009.

Department of Water Resources. "An Overview of the Draft Conservation Strategy for the Bay Delta Conservation Plan (BDCP)." December 17, 2008. BDCP Steering Committee.

EBM Tools Network. Retrieved from www.www.ebmtools.org on January 15, 2009.

Ehler, Charles and Fanny Douvere. 2006. *Visions for a Sea Change. Report of the First International Workshop on Marine Spatial Planning.* IOC and Man and the Biosphere Programme. IOC Manual and Guides No. 48, IOCAM Dossier No. 4. Paris: UNESCO, 2007

Eilperin, Juliet. May 4, 2009. "Finding Space for All in Our Crowded Seas." The Washington Post.

Endangered Species Act. 1973. Retrieved from http://www.nmfs.noaa.gov/pr/laws/esa/ on March 16, 2009.

Environmental Law Institute (ELI). July, 2007. Ecosystem-Based Management: Laws and Institutions. Retrieved from http://www.eli.org/Program_Areas/ocean_ebm.cfm on April 26, 2009.

ELI. 2009. *Expanding the Use of Ecosystem-Based Management in the Coastal Zone Management Act*. Lead author: Adam Schempp.

Food and Agriculture Organization (FAO). 2003. "Fisheries Management 2: The Ecosystem Approach to Fisheries." FAO, Rome.

Gopnik, Morgan. October 2008. *Integrated Marine Spatial Planning in U.S. Waters: The Path Forward.* Prepared for the Marine Conservation Initiative of the Gordon and Betty Moore Foundation.

Halpern, Ben, Carrie Kappel, Kimberly Selkoe, Fiorenza Michelie, Colin Ebert, Caitlin Kontgis, Caitlin Crain, Rebecca Martone, Christine Shearer, Sarah Teck. 2009. *Mapping cumulative human impacts to California Current marine ecosystems*. Conservation Letters, pp. 1-11. doi: 10.1111/j.1755-263X.2009.00058.x

Halpern, B.S. McLeod, K., Rosenberg, A. and L.B. Crowder. 2008. *Managing for Cumulative Impacts in Ecosystem-Based Management through Ocean Zoning*. Ocean and Coastal Management, Vol. 51, p 203-211.

Halpern, B.S., Walbridge S., Selkoe K.A., Kappel, C., Micheli, F., D'Agrosa, C., Bruno, J., Casey, C., Ebert, C., Fox, H., Fujita, R., Heinemann, D., Lenihan, H., Madin, E., Perry, M. Selig, E., Spalding, M., Steneck, R. and R. Watson. 2008. *A Global Map of Human Impact on Marine Ecosystems*. Science. Vol. 319, pp. 948-952.

Halpern, B.S., Walbridge S., Selkoe K.A. et al. 2008. *A Global Map of Human Impact on Marine Ecosystems* (supporting material). Retrieved from http://www.sciencemag.org/cgi/content/full/sci;319/5865/948/DC1

Halpern, B.S., McLeod K.L., Rosenberg A.A., Crowder L.B. 2008. *Managing for Cumulative Impacts in Ecosystem-Based Management through Ocean Zoning.* Ocean and Coastal Management, Vol. 51, pp. 203-211.

Halpern, Ben, Kimberly Selkoe, Fiorenza Micheli, Carrie Kappel. 2007. *Evaluating and Ranking the Vulnerability of Global Marine Ecosystems to Anthropogenic Threats*. Conservation Biology, Vol. 21, No. 5, 1301-1315

Halpin, et al. in prep. "Opportunities for EBM Tools." Retrieved from http://www.ebmtools.org/about_ebm_tools.html on May 15, 2009.

Harley, C.D.G., Hughes, A.R., Hultgren, K.M., Miner, B.G., Sorte, C.J.B., Thornber, C.S., Rodriquez, L.F. Tomanek, L. Wiliams, S.L. 2006. *The impacts of climate change in coastal marine systems*. Ecology Letters. Vol. 9, pp. 228-241.

Heiman, K., and Dean Wendt. 2006. *Connecting the many scales of marine EBM,* in "The Evolution of Ecosystem Based Management: From Theory to Practice." Proceedings from the 6th Marine Law Symposium, Roger Williams University School of Law.

Joint Ocean Commission Initiative. January 2009. "One Coast, One Future: Securing the Health of West Coast Ecosystems and Economies." c/o Meridian Institute.

Kappel, Carrie V., Rebecca G Martone, J. Emmett Duffy. 2006. "Ecosystem-based management." In: Encyclopedia of Earth. Eds. Cutler J. Cleveland (Washington, D.C.: Environmental Information Coalition, National Council for Science and the Environment). Retrieved from http://www.eoearth.org/article/Ecosystem-based_management on May 2, 2009

Kappel, Carrie, Ben Halpern, Rebecca Martone, Fiorenza Micheli, Kimberly Selkoe. Spring 2009. *In the Zone: Comprehensive Ocean Protection.* Issues in Science and Technology.

Kearney et al. 1991, *Island land loss and marsh vertical accretion rates evidence for historical sea-level rise changes in Chesapeake Bay*. Journal of Coastal Research, Vol. 7, No. 2, 403-415.

Knowles, Noah. 2008. Potential inundation due to Rising Sea Levels in the San Francisco Bay Region, California Climate Change Center, CEC-500-2009-023-F.

Lester, S.C. Costello, B. Halpern, C White, J. Barth, S. Gaines (in preparation) Ecosystem service tradeoff analysis.

Manji, Neil. Branch chief of the Department of Fish and Game's inland fisheries division.

Marine Ecosystems and Management (MEAM). June-August 2008. *Watershed Management: Putting EBM into Practice, Upstream from the Marine Environment*. Published by Marine Affairs Research and Education, University of Washington School of Marine Affairs. Vol. 1, No. 4. Retrieved from www.meam.net.

Marine Mammal Protection Act. 1972. Retrieved from www.nmfs.noaa.gov/pr/laws/mmpa/text.htm on May 1, 2009.

Martin, Glen. January-March 2009. "Taking the Heat: Bay Area Ecosystems in the Age of Climate Change." *Bay Nature*, Bay Nature Institute: Berkeley, CA.

McClure, Robert, and Lisa Stiffler. May 3, 2005. "A License to Kill: Flaws in Habitat Conservation Plans Threaten Scores of Species." Seattle Post Intelligencer.

McLeod, K.L., J Lubchenco, S.R. Palumbi, and A.A. Rosenberg. 2005. *Scientific Consensus Statement on Marine Ecosystem-Based Management.* Communication Partnership for Science and the Sea, Corvallis, OR. Retrieved from http://compassonline.org/marinescience/solutions_ecosystem.asp on April 16, 2009.

McLeod, Karen and Heather Leslie, Editors. 2009. *Ecosystem-Based Management for the Oceans*. Island Press: Washington DC, 392 p.

Millennium Ecosystem Assessment. Retrieved from http://www.maweb.org/en/index.aspx on May 2, 2009.

Mount, Jeffrey and Robert Twiss. 2005. Subsidence, Sea Level Rise and Seismicity in the Sacramento-San Joaquin Delta. San Francisco Estuary and Watershed Science. Vol. 3, Issue 1, Article 5. Retrieved from http://repositories.cdlib.org/jmie/sfews/vol3/iss1/art5 on April 1, 2009.

Murawski, Stephen. June 6, 2008. Lead IEA Priority Area Task Team. "Update on Integrated Ecosystems Assessments." NOAA Coordination Meeting, PowerPoint Presentation.

National Center for Ecological Analysis and Synthesis. University of California Santa Barbara. Retrieved from http://www.ia.ucsb.edu/pa/display.aspx?pkey=1979 on Feb 1, 2009.

National Environmental Protection Act. 1969. Retrieved from http://www.epa.gov/region/nepa/ on March 5, 2009.

National Oceanic and Atmospheric Administration (NOAA). "New Priorities for the 21st Century: NOAA's Strategic Plan." FY 2009-2014. Retrieved at http://www.ppi.noaa.gov/PPI_Capabilities/spo.html on February 19, 2009.

NOAA. Integrated Ecosystem Assessments. Retrieved from http://coastalscience.noaa.gov/about/iea.html on December 7, 2008.

Natural Capital Project. Retrieved from http://www.naturalcapitalproject.org/toolbox.html#InVEST on April 6, 2009.

Norse, Elliott A. 2005. *Ending the Range Wars on the Last Frontier: Zoning the Sea*. Marine Conservation Biology, pp. 422-444.

Norse. Elliott. 2002. *A Zoning Approach to Managing Marine Ecosystems*. pp. 53-58 in B. Cicin-Sain and C. Ehler, editors. Proceedings of workshop on improving regional ocean governance in the U.S., Washington D.C. Center for the Study of Marine Policy, Newark, Delaware.

Obama, Barack. June 12, 2009. Presidential proclamation and Memorandum, as part of National Oceans Month. Retrieved from http://www.presidency.ucsb.edu/ws/index.php?pid=86282

O'Boyle, R. and Glen Jamieson. 2006. *Observations on the implementation of ecosystem–based management: Experiences on Canada's east and west coasts.* Fisheries Research, Vol. 79, 1-12.

Oceans Conservation, Education, and National Strategy for the 21st Century Act (OCEANS-21), H.R. 21, 110th Congress. 2007.

Pacific Fishery Management Council. Retrieved from http://www.pcouncil.org/ecosystem/eco.html on May 2, 2009.

Pendleton, Linwood. 2007. *The Economic and Market Value of Coasts and Estuaries*, Executive Summary. Restore America's Estuaries.

Pew Oceans Commission. 2003. *America's Living Oceans: Charting a Course for Sea Change.* Pew Oceans Commission, Arlington, VA.

Physical Oceanographic Real Time System. Retrieved from http://tidesandcurrents.noaa.gov/ports.html; and http://sfports.wr.usgs.gov/SFPORTS/object.shtml on April 27, 2009.

Point Reyes Bird Observatory, California Current Joint Venture: Building collaboration at the Regional Scale. Retrieved from http://www.prbo.org/cms/231 on May 1, 2009.

Puget Sound Partnership. Retrieved from http://www.psp.wa.gov on May 5, 2009.

Roman et al. 1997, *Accretion of a New England (USA) salt marsh in response to a inlet migration, storms and sea-level rise*. Estuarine Coastal and Shelf Science, Vol. 45, No. 6, 717-727.

Rosenberg, Andrew and Karen McLeod. 2005. *Implementing ecosystem-based approaches to management for the conservation of ecosystem services*. Marine Ecology Progress Series, Vol. 300, pp. 270-274.

Ruhl, J.B. 2004. E"ndangered Species Act Innovations in the Post-Babbittonian Era-Are There Any?" *Duke Environmental Law and Policy*, 14, 419-430.

Sainsbury, Keith. 2008. *Sustainable Use with Changing Ecological Processes*. Presentation at Coast to Coast '08, Darwin, Australia.

San Francisco Bay Conservation and Development Commission (BCDC). 2009. *Living with a Rising Bay: Vulnerability and Adaptation in San Francisco Bay and on the Shoreline.*

BCDC. 1969. *The San Francisco Bay Plan.*

BCDC. 1965. *The McAteer-Petris Act.*

San Francisco Estuary Institute (SFEI). 2008. *The Pulse of the Estuary*, A Report of the Regional Monitoring Program for Water Quality in the San Francisco Estuary.

SFEI. Retrieved from http://www.exoticsguide.org and http://www.sfei.org/bioinvasions on May 4, 2009.

SFEI. Regional Monitoring Program. Retrieved from http://www.sfei.org/rmp/ on January 6, 2009.

Selkoe, K.A., Halpern, B.S., Ebert C.M. et al. 2009. *A Map of Human Impacts to a 'Pristine' Coral Reef Ecosystem: the Papahanaumokuakea Marine National Monument.* Coral Reefs. doi: 10.1007/s00338-009-0490-z.

Senecah, S., Jack Manno, William Wise, David Conover. September 2006. *Ecosystem-based Management in New York State: Taking the Next Steps.* Summary Report to the New York Ocean And Great Lakes Ecosystem Conservation Council.

Sivas, D.A., and MegCaldwell. 2008. *A New Vision for California Ocean Governance: Comprehensive Ecosystem-Based Marine Zoning.* Stanford Environmental Law Journal. Vol. 27, pp. 209-270.

Trulio, Lynne (lead author). November 14, 2007. "South Bay Salt Pond Adaptive Management Plan." Science Team Report.

Tudela, Sergi and Katherine Short. 2005. Paradigm shifts, gaps, inertia, and political agendas in ecosystem based fisheries management. Marine Ecology Progress Series. Vol. 300, pp 282-286.

Turrell, WR. 2004. *The policy basis of the ecosystem approach' to fisheries management*. EuroGOOS. Publication No. 21.

University of Queensland, Australia. Marxan: Informing Conservation Decisions Globally. "Getting Started." Retrieved from http://www.uq.edu.au/marxan/index.html?page=77645&p=1.1.3.1 on April 3, 2009.

U.S. Commission on Ocean Policy (USCOP). 2004. *An Ocean Blueprint for the 21st Century*. Final Report to the President and Congress. U.S. Commission on Ocean Policy, Washington D.C.

U.S. Ocean Action Plan. 2004. The Bush Administration's Response to USCOP. Retrieved from http://ocean.ceq.gov/actionplan.pdf on April 1, 2009

Warren, Brad. 2007. *Sea Change: Ecological Progress in U.S. Fishery Management*. A report jointly commissioned by the institute of Social and Economic Research (ISER) and the Marine Conservation Alliance.

West Coast Ecosystem-Based Management Network (EBM Network). Retrieved from http://www.westcoastebm.org/Network_Home.html on January 19, 2009.

West Coast Governor's Agreement (WCGA). 2006. West Coast Governors Agreement on Ocean Health. Retrieved from http://westcoastoceans.gov/docs/WCOceanAgreementp6.pdf on April 20, 2009.

WCGA. 2007. Draft Action Plan. West Coast Governors Agreement on Ocean Health. Retrieved from http://seagrant.oregonstate.edu/research/RegionalPlanning/index.html

Woodard, Colin. January 5, 2001. *Maine's Catch.* The Lobster Conservancy. Retrieved from http://www.lobsters.org/press/chrnhe/chrnhe.html on April 20, 2009.

Young, Oran R., Gail Osherenko, Julia Ekstrom, Larry Crowder, John Ogden, James Wilson, Jon Day, Fanny Douvere, Charles Ehler, Karen McLeod, Ben Halpern, Robin Peach. May 2007. *Solving Ocean Governance.* Environment, Vol. 49. No. 4. pp. 20-32.